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PART 8

GENERAL MECHANICAL REQUIREMENTS

8.1 Wet Wells

(a) In order to prevent surcharging of sewers, the maximum level of sewage in the suction/wet well of the TSPS/ISPS shall be limited to 500 mm below the invert of the lowest incoming sewer.

(b) For the TSPS/ISPS, in order to prevent sewage from turning septic, maximum retention of sewage in the wet / suction well shall not exceed 30 minutes for the average flow.

(c) The depth of sump shall be such that it provides at least 15 % margin over the minimum required pump submergence calculated at duty point on the basis of the Hydraulic Institute Standard.

(d) The wet well effective operating volume (volume between low level where all pumps are shut off and high level where all pumps except standby are operating) shall be such that the hydraulic retention time in this volume at peak flow is not less than 5 minutes and the number of starts per hour does not exceed 6 for any single pump under any circumstances.

(e) Appropriate baffles shall be provided in the wet/suction well to prevent the excessive turbulence and air entrainment when free fall of material to be pumped occurs.

(f) Benching shall be provided at the bottom of the wet well towards the suction bell mouth to ensure that the pumps can be used to completely drain the wet well.

(g) The wet well design shall incorporate corner fillets and ogees as appropriate to eliminate dead spots, prevent accumulation of solids or debris, and to ensure that the wet well is fully self cleaning – automatically cleaned by the hydraulics of the flow.

(h) The top of the wet well wall, top of valve chamber walls and top of electrical cubicles structures shall be minimum of 500 mm above the finished ground level. No Buried/ Submerged structures shall be accepted for the wet well.

(i) Priming of pumps shall be ensured by providing positive suction head.

(j) Operation of sewage pumps shall be automatic based on the sewage levels in the wet well.

(k) Standby unit of each type and size of pump employed shall be provided as specified in particular mechanical requirement and these shall be minimum requirement.

(l) The clearance between pumps outer periphery shall be not less than 1000 mm.

(m) Sequence of operation of raw sewage pumps shall be changed every 8 hours to avoid accumulation of solids in the wet/suction well.

(n) + 5% margin on the pump capacity shall be provided for all the pumps.

(o) The total head of the pump shall be selected considering peak flow and maximum design level in the wet well for normal conditions of operation, and checked for satisfactory operation under extreme conditions of operation; the selected head to be revised if required.

(p) The minimum permissible velocity in the pumping mains shall be 0.8 m/sec. The maximum velocity in the pumping main shall not exceed 2 m/sec.

(q) All dry/wet well pumping stations shall be provided with a pit and drain pumps with rigid DI piping (1 working + 1 standby) to automatically empty the stuffing box drain and emergency maintenance.

(r) Ventilation shall be provided for all the pumping station based on 15 air changes per hour.

(s) For TSPS/ISPS, mechanical rake coarse/medium bar screen shall be provided upstream of the pumping station wet well. Provisions shall be made to allow lifting of screenings by belt conveyor.

(t) Appropriate lifting devices shall be provided for safe and easy retrieval and/or removal of the pumps from wet well or dry well for maintenance or any other purpose at all pumping stations.

(u) On the Common header of TSPS, ISPS, Primary Sludge, RAS, Thickened Sludge, Centrifuge feed, Digester sludge and all pumping system shall be provided with Motorised Knife Gate Valve on upstream of Flowmeter and Knife Gate Valve on downstream of Flowmeter.For TSPS and ISPS pumps swing check valve shall be provided on the individual header and also on the downstream of the common header.

8.2 Vertical Dry Pit Pumps

8.2.1 General

The total head capacity curve shall be continuously rising towards shut off with the highest at shut off.

(a) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistances.

(b) Pumps shall run smoothly without undue noise & vibration. Noise level shall be limited to 80 dB at 1.0 M from equipment. Vibration shall be limited to class II C of BS 4675/ zones A & B of ISO 10816. The pump set shall be suitable for starting with discharge valve open or closed.

(c) The pump set shall be capable of withstanding accidental rotation in reverse direction.

8.2.2 Features of Construction

(a) Pump shall be centrifugal, back pullout, single stage type.

(b) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed so as to allow free passage of solids. The volute tongue shall be straight across and filed to a smooth rounded edge. Casing shall be provided with wearing ring.

(c) Hand hole shall be provided in the casing to allow easy access to the impeller as well as to the casing throat. Casing drain connection with stainless steel collared plug shall be provided.

(d) Impeller shall be non clog, enclosed type with smooth blunt edges and large water ways so as to allow free passage of the 50 mm size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy material.

(e) The critical speed of the rotor shall be at least 30% above the operating speed. Complete rotor shall be balanced dynamically as per ISO 9906.The pump shut off head shall be minimum 110% and maximum 130% of the rated pump head.

(f) Replaceable shaft sleeves shall be provided and shall be securely locked or keyed to the shaft to prevent loosening. The surface hardness of the shaft sleeve shall be minimum 400 BHN.

(g) Bearings shall be easily accessible for inspection and maintenance. The bearings shall have a minimum working life of 100000 hours of working. Bearings shall be grease lubricated or non-grease type.

(h) Glands shall be fitted with suitable mechanical seals. The gland arrangement shall be designed for ease of adjustment or removal of the seal. Stuffing boxes shall be of such design that they can be repacked without removing any part other than gland and lantern ring. Stuffing box drain with pipe connection shall be provided at the lowest point so that no leakage accumulates in it.

(i) Mechanical seals shall be provided. Grease shall be used for stuffing box sealing. Water will not be available for this purpose.

(j) The pump and motor shall be coupled through a flexible coupling. The motor shall be mounted directly on pump casing.

(k) Tappings shall be provided at suction and discharge nozzles for pressure gauge connection. Water flushing arrangement shall be provided for cleaning of sludge pipe line at its delivery side.

(l) Impeller wear ring hardness shall be min 50 BHN higher than that of Casing wear ring.

(m) In Pump Head Calculations consider the following- Atleast 10% margin shall be considered over calculated frictional losses. Low water level shall be considered while calculating static head for pump head. Appropriate Residual head shall be considered in design of pumping head

(n) The material of construction for Centrifugal Dry Pit Pump shall be as follows:

Sr. No.	**Component**	**Material**	
		Non-clog type	**For clean water (for service water etc)**
(i)	Impeller *	Stainless Steel: ASTM A 743 CF8M	Stainless Steel: ASTM A 743 CF8M
(ii)	Casing *	Cast Iron to BS EN: 1561 Gr EN-GJL-200	Cast Iron to BS EN: 1561 Gr EN-GJL-200

Sr. No.	Component	Material	
		Non-clog type	**For clean water (for service water etc)**
(iii)	Shaft*	Stainless Steel: BS:970 Gr 431 S29	Stainless Steel BS:970 Gr 431 S29
(iv)	Shaft sleeve*	Stainless Steel: ASTM A 743 CA 15 Hardness 400 BHN	Stainless Steel: ASTM A 743 CA 15 Hardness 400 BHN
(v)	Casing ring*	Stainless Steel: ASTM A 743 CA 15	Stainless Steel: ASTM A 743 CA 15
(vi)	Impeller ring*	Stainless Steel: ASTM A 743 CA 15	Stainless Steel: ASTM A 743 CA 15
(vii)	Mechanical seal (Motor side and Pump side)*	oil-lubricated with tungsten carbide or silicon-carbide faces	oil-lubricated with tungsten carbide or silicon-carbide faces

* Material test certificates from government approved laboratory shall be furnished by the Contractor

8.3 Submersible Pumps (Dry / Wet pit Installation)

8.3.1 General

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the specifications without surging, cavitation or excessive vibration to the limits specified. The pump shall meet maximum allowable shut off head. The pumps shall not overload the motors at any point on the maximum pump speed performance characteristic curve and the pump operating range within the limits of stable pump operation. The total head capacity curve shall be continuously rising towards the shut off as flow decreases throughout the entire curve from run out to shut off head with the highest at shut off. Its total head capacity curve shall be continuously rising towards shut off with the highest at shut off, and its capacity shall be meet to handling sludge volume.

(a) Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistances.

(c) The pumps shall be designed to handle solid sizes of up to 100 mm for the raw sewage application and 50 mm for all other process fluids. Specific gravity of sewage is 1.02 and Sludge 1.05.

(d) Pumps shall run smooth without undue noise and vibration, cavitation, oil or water leaks over the range of operation. To ensure vibration free operation, all rotating components of pump shall be statically and dynamically balanced to BS 6861. as per zones A& B of ISO 10816 -1 Vibration levels shall not exceed the levels given in BS 4675.Abnormal sound and noise from pump set and or motor will not be acceptable.

(f) The pump set shall be suitable for starting with discharge valve open and/or closed.

(g) The pump set shall be capable of withstanding the accidental rotation in reverse direction.In Pump Head Calculations consider the following- Atleast 10% margin shall be considered over calculated frictional losses. Low water level shall be considered while calculating static head for pump head. Appropriate Residual head shall be considered in design of pumping head

8.3.2 Features of Construction

(a) Pump shall be centrifugal, vertical spindle, non-clog, wear resisting, and single stage type.

(b) Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow free passage of solids. The volute tongue shall be filed to a smooth rounded edge.

(c) Double Mechanical seals (back to back) shall be provided to protect the motor from ingress of sewage along the shaft. The preliminary and secondary seals shall be oil-lubricated with tungsten carbide or silicon-carbide faces and they shall be equipped with an electrical monitoring system for seal failure detection. . Seals must be capable of withstanding rotation in either direction. A detector shall indicate when moisture is leaking past the first seal.

(d) Impeller shall be non-clog enclosed type with smooth blunt edges and large water ways so as to allow free passage of the large size solids. It shall be free from sharp corners and projections likely to catch and hold rags and stringy materials.

(e) The critical speed of the rotor shall be at least 30% above the operating speed.The pump shut off head shall be minimum 110% and maximum 130% of the rated pump head.

(f) Pump-sets shall have double bearings. Bearings shall be of the anti-friction type. Bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump. The bearing life shall be minimum 100,000 hrs of operation.

(g) Each pump shall be complete with a cast iron delivery connection arrangement for fixing to the concrete floor of the suction well. The joint between the pump discharge flange and the delivery piping shall be made by merely lowering the pump into guide rails / rope from access level. It shall be provided with all necessary fixings for guiding the pumps during lifting/lowering. Each pump shall be provided with a SS 316 lifting chain conforming to BS 1663 and BS 4942.

(h) Each pump shall be provided with an automatic coupling device for attaching to the duck foot bend base at low level by using lifting chain SS 316 and guide rail SS 316, even whilst the pump is submerged, without the need for personnel to enter the well. This automatic coupling device shall easily and automatically couple and uncouple from the duck foot bend base and be complete with necessary accessories. All links and cables shall be multi-stranded stainless steel.

(i) The materials of construction for submersible pumps (Screw/Chopper vane/Vortex type/Any type of impeller) shall be as follows:

S. No.	Component	Material
(i)	Impeller *	Stainless Steel : ASTM A 743 CF8M
(ii)	Casing *	Cast Iron to IS:210 Gr FG 260
(iii)	Mechanical seal (Motor side and Pump side)*	oil-lubricated with tungsten carbide or silicon-carbide faces
(iv)	Shaft*	Stainless Steel : BS:970 Gr 431
(v)	Bush*	Bronze IS 318 Gr. LT B2
(vi)	Guide rail pipe #	Stainless Steel : BS:970 Gr 316
(vii)	Lifting Chain	Stainless Steel : AISI 316
(viii)	Fasteners and Foundation Bolts	Stainless Steel AISI 316L

* Material test certificates from Government approved metallurgical laboratory shall be furnished by the Contractor.

(j) Each pump shall be tested at the manufacturers premises for the full operating range of the pump to BS 5316 Part 1. Pump performance shall be within the tolerance limits specified in the above said BS.

8.4 Submersible Vertical Propeller Pumps

Application where larger volumes must be pumped up to relatively low heads Vertical Propeller Tube Type pumps should be used. Tube shall be of SS 316 material with minimum 8 mm thick.

Design Requirements

(a) Pump

Pumps shall be compact, single stage, submersible propeller Axial tubular type tube installed, vertical shaft, wear resisting, designed to install vertically in a Stainless steel tube with an automatic coupling, suitable for screened sewage applications.

Pumps shall be designed for continuous operation under submerged conditions as well as Intermittent operation.

Pumps shall be fitted with dynamically balanced non clog Propeller designed to pass coarse solids of at least 50 mm diameter.

The equipment shall be capable of developing the required total head at rated capacity. Total head capacity curve shall be continuously rising from minimum head to maximum head.

Pump operating speed shall be less than 1000 rpm.

Pumps shall run smooth without undue noise and vibration. The velocity of vibration should be as per Part-14. The noise level should be limited to 85 dBA at a distance of 1 M.

Pump should be equipped with double mechanical seals. Lower sealing between Impeller and Oil chamber and upper sealing between Oil chamber and motor winding.

In Pump Head Calculations consider the following- Atleast 10% margin shall be considered over calculated frictional losses. Low water level shall be considered while calculating static head for pump head. Appropriate Residual head shall be considered in design of pumping head

(b) Submersible Motor

Motor should be water pressure tight encapsulated, fully flood-proof motor, 3 phase Squirrel Cage Induction Motor, 415V +10%, 50 Hz, with IP-68 Enclosure with Class H Insulation, Temperature Rise: according to class A, IE3 / IE2 Premium Efficiency Motor accordance with IEC60034-30, ATEX Explosion Proof Version suitable for submergence upto 20 m or Non-Explosion proof motors both can be offered.

Water pressure sealed connection chamber, with two stage cable entry, protected against excessive cable tension and bending. The cable shall be EPR insulated Double sheathed designed and certified for permanent use in sewage water and suitable for a conductor Temperature of 80 °C.

Motor should be of Low temperature rise so that it allows for high service factor. Minimum service factor should be 1.3. 30% safety margin against overheating when a motor is operated under full load:
- At low line voltage
- At generator sets, which are slightly over speeding
- In medium with temporarily higher temperature

Propeller pump, pumps the liquid upwards in the steel pipe which will flow around the motor with this action motor cooling happens automatically.

All Motors should be suitable for use with VFD.

The installed power rating of the motor should be the larger than 120% of the power required at the duty point.

Bi-Metallic Thermal sensors should be provided in the each phase of motor winding & both (Upper & Lower) bearings to monitor temperature rise in motor windings and bearings. The sensors shall be connected in series and shall be coupled to the motor contactor coil such that any one-switch opening will shut down the motor.

Moisture sensors should be provided in motor housing, Mechanical Seal Oil Bath & connection chamber of the motor. Moisture Sensors with Electronic amplifier trip the Motor in case of ingress of water.

a. For Oil chamber - To detect the Mechanical Seal Failures.
b. For Motor housing - To monitor leaks in Motor housing.
c. For Connection Chamber - To detect failure through Cable entry.
d. Mating surfaces shall be watertight and fitted with nitrile O-rings.

(c) Features of Construction

Pump should be Vertical Shaft, wear resisting, single stage, submersible Propeller type, suitable for screened sewage applications.

Pumps should be identical and suitable for parallel operation with equal load division. Components of identical pumps should be interchangeable.

Pump casing should be of robust construction Liquid passages should be finished smooth and designed so as to allow free passage of solids as specified below.

Axial propeller with 3 or 4 propeller blades and diffuser on discharge side. Pumps should be provided with anti friction ball or roller type bearings, lubricated-for life, maintenance-free designed for a L10 bearing life of 100,000 hours at BEP and shall be of sufficient size to transfer all radial and axial loads to the pump housing and minimize shaft deflection. Maximum shaft deflection should be 0.05 mm at mechanical seal face.
Pump should be furnished complete with coupling ring for welding in the steel pipe to hold the pump in steel tube, Lifting chain, Power & Control Cable, Motor control system, control panel and level switches.

For lifting of pump Stainless Steel Lifting hoop/handle fitted on the motor top should be provided.

All mating surfaces of the pump and motor shall be machined and fitted only with Orings (NBR) where watertight sealing is required.

Pump should be equipped with double mechanical seals. Lower sealing by means of a SIC/SIC between Impeller and Oil chamber and upper sealing by SIC/SIC mechanical seal between Oil chamber and motor winding, independent of the direction of rotation.

Propeller and Rotor shaft should be dynamically balanced.

The Pump set shall be capable of withstanding the accidental rotation in reverse direction.

Description	**Material of Construction**
Cooling/oil chamber, Connection chamber, Motor housing, Diffuser / Inlet Diffuser	CI IS 210 Gr. FG.260
Shaft	Stainless Steel AISI 431
Propeller Blades	SS ASTM A 743 Gr.CF8M
O-ring/Seals	Nitrile rubber (NBR)
Fasteners	

	SS 316L
Lifting Chain	SS 316

(d) Specific Requirements of VFD Driven Motors

The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.

The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.

The motor shall be designed to operate continuously at any speed over the range 10-100 % of rated speed.

The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.

The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.

The driven equipment manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the driven equipment.

8.5 Chemical Feeding Equipment

8.5.1 Chemical Dosing Pumps

(a) Chemical dosing pumps shall be piston, piston diaphragm or mechanical diaphragm type as specified. Pumps may be simplex or duplex arrangements to suit the capacity or process requirements. The pump design shall incorporate positive stroke return. The maximum stroking speed shall not exceed 100 strokes per minute (spm). Pump, motor and driving arrangement shall be mounted on a robust combined baseplate.

(b) Pump liquid ends shall be selected for compatibility with the pumped liquid. Suction and discharge valves shall be the single ball type allowing a free flow self cleaning action. Ball and seat materials shall be resistant to abrasion.

(c) Pumps shall incorporate a variable stroke mechanism to allow the output to be varied while the pump is running. Stroke adjustment shall be manual or where specified by electrical or pneumatically controlled stroke positioner. A stroke length indicator and digital stroke counter shall be fitted. Pumps shall be driven by a flange mounted IP 55 motor, via an oil bath reduction gearbox and variable stroke mechanism giving stepless adjustment between zero and maximum stroke length. Where flow proportional dosing is required the variation of output shall be achieved by varying the speed of the pump motor and not the pump stroke length.

(d) The normal operating range of dosing pump shall be not less than 6:1.

a. Mechanical Diaphragm Diaphragm rigidly coupled to the drive train. Single suction Pumps and discharge valves. Glandless. Accuracy: ± 3% of stoke.
b. Piston Pumps Cylinder and piston with packed gland. Double suction and discharge valves can be fitted for greater accuracy at high pressure. Accuracy: ± 1% of stroke.
c. Piston Diaphragm Pumps Diaphragm hydraulically operated by liquid displaced by a plunger and protected from excess pressure via a relief valve. Accuracy: ± 2% of stroke.

Materials shall be selected to suit the chemicals being pumped. Liquid ends shall be polypropylene, 316 stainless steel, glass, or Hastelloy C. Diaphragm materials shall be butyl rubber, PTFE, or Hypalon and glands shall be PTFE or Neoprene.

(e) Each pump shall be provided with inlet and outlet isolating valves and with pressure relief and non-return valves. Dosing pumps shall be provided with back pressure loading valves and pulsation dampeners in the delivery lines.

(f) A relief valve shall be incorporated in the delivery lines under conditions where the pump discharge pipe can be shut off or where pressure may rise to an excessive point. The relief valve shall be sized to handle the system pressure and to discharge maximum pump output freely, and shall be located in the discharge line between the pump and the first downstream isolating valve or in the case of dosing pumps the back pressure loading valve. Relief valves when used on pumps handling non-hazardous chemicals shall discharge the vented liquid to waste. When used on hazardous chemicals the valve outlet shall be piped back to the suction supply tank or bunded area. The open end of the return pipe shall be located where it is visible, so that any relief valve leakage/operation can be detected. Pump transferring/dosing chemicals to systems under pressure shall incorporate a pressure gauge on the pump delivery. Air cocks shall be provided for release of air where necessary.

(g) Unless otherwise specified flushing connections shall be provided at each pump inlet and flushing shall be manual. When flushing, water shall be discharged either locally through a drain valve or to the point of application of the chemical. Facilities shall also be provided for flushing chemical pump suction and delivery manifolds and delivery lines to point of application.

(h) Dosing pumps and motors shall preferably incorporate an integral reduction gearbox drive which shall be totally enclosed and oil bath lubricated. The gear box shall incorporate the cams for the diaphragm drive and shall be provided with filling and drain connections and visible oil level indication.

(i) All dosing pumps shall have facility/terminals for pulse input & output (4-20 mA) to facilitate online control via plant PLC & SCADA.

8.5.2 Chemical Tank and Mixer

(i) General

This tank shall be used to dissolve the alum or polymer to a constant concentration and feed the solution to the outlet channel of the aeration tank or the dewatering equipment. It shall be a vertical tank and

shall be composed of tank main body, mixer, manhole, electrical level gauges, direct reading level gauge, ladder, air exhaust pipe etc.

(ii) Fabrication

(a) The tank shall be made of corrosion resistant material.

(b) The tank shall be provided with a removable cover to prevent chemical scattering, and also with a vent pipe.

(c) The tank shall be provided with necessary mounting seats for overflow pipe, etc.

(d) The motor-driven mixer shall be vertical speed reducer, direct-coupled type of 2-stage propeller type, as a rule and shall be constructed to endure continuous operation free from vibration, etc. The mixer shall be at the center or at a position off the center according as the tank being angular or circular.

(e) The mixer shall be protected by electrical prevention of dry operation.

(f) The tank shall be constructed to seal gas and splash from below at the area where the mixer shaft drive portion passes through.

(g) Alum feed cage of stainless steel shall be provided inside the alum solution tank.

(iii) Materials

(a) Main Tank body : GRP/HDPE
(b) Mixer frame : SS316
(c) Mixer shaft : SS316
(d) Blade/Impeller : SS316L

(iv) Accessories (per Unit)

(a) Foundation bolt and nut x 1 set
(b) Air vent pipe x 1 set
(c) Mixer x 1 unit
(d) Direct reading level gauge x 1 unit

8.5.3 Alum Dispersion Rapid Mixer

(a) The alum dispersion rapid mixer shall be in-channel submersible chemical vacuum induction unit and consist of chemical induction unit with mount bracket, guide rail assembly, floor mount base, boom hoist with manual brake winch and SS 316 cable, hose assembly, control panel and submersible power cable.

(b) The unit shall be provided instantaneous diffusion/mixing and the highest level of durability and performance required for chemical feed application.

(c) The hermetically sealed SS 316 motor shall provide the highest level of durability and performance required for chemical feed applications. All wetted materials shall be constructed from Grade 2 Titanium (unalloyed) and shall be designed for use with all common water and wastewater treatment chemicals. The mounting bracket shall be engineered for installing in open-channel applications.

(d) The material of construction of chemical induction shall be as follows:

S. No.	Component	Material
(i)	Vacuum chamber	Titanium
(ii)	Vacuum port	Titanium
(iii)	Vacuum enhancer	Non-metallic
(iv)	Propeller	Titanium
(v)	Propeller bolt	Titanium
(vi)	Shaft	Titanium
(vii)	Mechanical seals	Carbon /ceramic
(viii)	Hardware	SS 316L

8.6 Induction Motors

Motor for Dry pit Sewage/ Sludge Pumps/ Air Blowers

8.6.1 Design Requirements

The motors shall be suitable for operating on a 415 V, 50 Hz, 3 phase, Ac supply.

The motors shall generally conform to IS: 325 or relevant equivalent internationally approved standards. Additionally the specific requirements mentioned in the following clauses shall also be met. All motors shall be IE-2/IE-3 energy efficient type.

8.6.2 Performance and Characteristics

(a) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

(i) Variation in supply voltage $\pm$ 10%
(ii) Variation in supply frequency $\pm$ 5%
(iii) Combined voltage and frequency variation ±10%

(b) Motors shall be suitable for full voltage direct-on-line starting or star delta starting. Minimum permissible starting voltage shall be 85% of the rated voltage.

(c) The Power rating of the motor shall be the larger of the following:

(i) 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 49.0 Hz.

(ii) Maximum power input while operating single pump corresponding to the speed of 50 Hz.

8.6.3 Insulations

Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with class F insulation with temperature rise limited to that of class B insulation. The degree of enclosure protection of motors shall be of minimum IP 55.

Motors shall be given power house treatment. This comprises an additional treatment to the winding over and above the normal specified treatment. After the coils are placed in slots and all connections have been made, the entire motor assembly shall be impregnated by completely submerging in suitable insulating compound or varnish followed by proper baking. At least three such submersions and backings shall be applied to the assembly.

Motors which are VFD controlled shall be inverter grade and shall be suitably derated to take care of reduced cooling at lower speeds.

Insulation of VFD controlled Motors shall be designed to withstand a dv/dt of 0.1 micro sec rise from 10 % to 90 % of steady voltage and a maximum peak of 1600 volts as per NEMA standard MG1 Part 31.40.4.2.

The insulation shall be of double coat winding wires which having superior electric strength and thermal capability for VFD controlled motors.

Winding shall be insulated as VPI (Vacuum Pressure Impregnation) of winding with suitable resin forces which eliminating voids for VFD controlled motors.

8.6.4 Constructional Features

The motor construction shall be suitable for easy disassembly and reassembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

a) Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.
b) The rotor bars shall not be insulated in the slot portion between the iron core laminations for squirrel cage motors.
c) All windings shall be of Copper. The winding insulation shall be Non-hygroscopic, oil resistant and, flame resistant
d) Noise level and vibration limit should not exceed as specified in relevant IS / IEC.

8.6.5 Terminal Box

Terminal boxes shall be of weather proof construction designed for outdoor service and shall have a degree of protection of at least IP 55 for out door application. To eliminate entry to dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor

frame. It shall be suitable for bottom entry of cables. It shall be capable of being turned through 360 degrees in steps of 90 degrees.

The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. They shall be designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearances. Suitable cable glands and cable lugs shall be supplied to match specified cables.

Sizes of terminal boxes and lugs shall be as given in below Table, unless specified otherwise in data sheet.

415 V Motors - Sizes of Cables, Studs, Terminal Lugs & Terminal Boxes

(To Be Provided on Motors by Vendor)

Sl No.	Motor Rating (kW)	1100V Al Conductor, armoured PVC/XLPE Cable Cores x mm^2
1.	Upto 3	3x4
2.	3.1 - 7.5	3x6
3.	7.6 - 15	3x16
4.	16 - 25	3x35
5.	26 - 40	3x70
6.	41 - 55	3x120
7.	56 - 70	3x185
8.	71 - 85	3x240
9.	86 - 110	3x400
10.	111 - 200	3Rx1Cx500

Separate terminal boxes shall be provided for the following:

(i) Starter leads; and

(ii) Space heater

8.6.6 Accessories

Two independent earthing points shall be provided on opposite sides of the motor, for bolted connections. These earthing points shall be in addition to earthing stud provided in the terminal box. Totally 9 no. of sensors shall be installed for having proper bearing and winding temperature system.

8.6.7 Heating during Idle Period

For motors rated below 30 kW, during idle periods, the stator winding will be connected to required single phase, 50 Hz, AC supply for heating and elimination of moisture. The supply will be connected between any two terminals.

Motors rated 30 kW and above shall have space heaters suitable for 230V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

8.6.8 Earthing Pad

Two independent earthing pads of non-corrodible metal shall be welded or brazed at two locations on opposite sides complete with suitable bolt and washers for earthing. These earthing pads shall be in addition to earthing stud provided in the terminal box.

8.6.9 Rating Plate

The following details, in addition to those specified in applicable standards shall be included on the rating plate.

Rated voltage, kW rating, frequency, efficiency, power factor, temperature rise of windings in degree centigrade at rated load, and ambient conditions.

Type of bearings, recommended lubricant, lubricating interval & re-lubricating quantity.

8.6.10 Paint and Finish

All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

8.6.11 Tests

Motor shall be subjected to all the type test (one from similar rating of each lot) and routine tests as per applicable standard in the presence of the Engineer. Copies of test certificates for all brought out items shall be furnished at the time of inspection for the Employer's approval. The Contractor shall ensure to use calibrated test equipment / instruments having valid calibration test certificates from standard laboratories traceable to National / International standards.

8.6.12 Low Voltage Motors

Motors shall be suitable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 85% of the rated motor voltage.

The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard). The locked rotor current of VFD controlled motor shall be within the limit of IS12615 / IEC.

Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation.

Stator leads shall be brought to the terminal box as insulated cable through a suitable barrier and terminated in clamp type terminals.

Motors shall be provided with smart sensors for condition monitoring solution that makes predictive maintenance possible for motors. Condition monitoring means that maintenance activities can be planned, which reduces downtime can be planned in advance, reduces downtime and supports longer motor lifetimes. At the same time, the solution generates big data on the status of large numbers of motors, paving the way for predictive of operations and energy consumption.

The sensor monitors signals from the motor accurately measuring key parameters at regular intervals and it transfers the data and convert in to meaningful information, which sent to the user's smart phone and customer portal by using built-in Bluetooth low energy technology to a smartphone or gateway and to secure cloud-based server.

The smart sensor shall be measured following parameters:

i) Overall motor condition
ii) Overall vibration
iii) Bearing condition
iv) Misalignment
v) Skin temperature
vi) Output power, operating hours, number of starts and speed

Motors rated 7.5 kW and above shall be provided with space heaters with adequate capacity to maintain motor temperature to prevent moisture condensation on the insulation during idle condition. The space heaters shall be suitable for 240V single phase 50 Hz supply. The degree of enclosure protection of motors shall be of minimum IP 55.

8.6.13 HV Motor (For Process Air Blowers)

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is 80% of the rated voltage.

(a) Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.

(b) The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than starting time at minimum permissible voltage by at least three seconds or 15% of the accelerating time whichever is greater. The locked rotor current of motors shall not exceed 600% of full load current of motors which is inclusive of 20% tolerance.

i. 600% of full load current for motors upto and including 1500 kW, except for mill motors

ii. 450% of full load current for motors above 1500 kW

(c) Motors when started with the drive imposing its full starting torque under the specified supply voltage variations shall be capable of withstanding at least two successive starts from cold condition and one start from hot condition without injurious heating of windings. The motors shall also be suitable for three equally spread starts per hour under the above referred supply conditions.

(d) The three phases shall be segregated by metal barriers within both line and neutral terminal box.

(e) The earthling pads shall be of non-corrodible metal, welded/brazed at two locations on opposite sides. The pad size shall be 75 x 65 x 25 mm with two holes drilled at 40mm centers, tapped & provided with suitable bolts and washers for connecting the earthling strip.

(f) Insulation & Cooling

i. All Motors shall have class F insulation but, limited to class B temperature rise.

ii. The insulation system shall withstand steep front impulse voltage of value given as per Table-1 of IEC-34-15 having front time of 0.2 microseconds.

iii. The motor shall be self-ventilated type, either totally enclosed fan cooled (TEFC).

iv. For large capacity motors, totally enclosed tube ventilation (TETV) shall be considered.

(g) Temperature Rise

i. The temperature rises for air cooled motors shall not exceed 70 deg C by winding resistance measurement method.

ii. At least six resistance type temperature detectors for the stator winding each having D.C. resistance of 100 ohms at 0 degrees Celsius, embedded in the stator winding at locations where highest temperatures may be expected, shall be provided. The material of the RTD's shall be platinum. Totally 9 no. of sensors shall be installed for having proper bearing and winding temperature system.

(h) At least one vibration detector for the stator winding, embedded in the stator winding at location where vibration may be expected, shall be provided. Compression-type piezoelectric type accelerometers, velocity transducers or proximity transducers shall be applied to the vibration detection system.

(i) Motors shall have space heaters suitable for 240V single phase 50Hz AC supply. These shall be placed in easily accessible position in the lower part of motor frame. Provision shall be made to measure temperature of bearing by inserting hand held temperature measuring device.

(j) Constructional Features

i. All insulated windings shall be of Copper. The winding insulation shall be Non-hygroscopic, oil resistant and, flame resistant.

ii. All Motors shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

iii. Motors shall have drain plugs so located that they will drain water, resulting from condensation or other causes from all pockets in the motor casing.

iv. Noise level and vibration limit should not exceed as specified in relevant IS / IEC.

v. Vibration pads shall be provided for all HT motors for mounting vibration detectors

(k) Terminal Box

i. Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base-plate/foundation.

ii. Separate terminal boxes shall be provided for each of the following:

- Stator Leads
- Rotor leads (wound motors)
- Space Heaters
- Temperature Detectors

iii. The three phases shall be segregated by barriers of metal or fibre glass. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.

iv. For Motor above 1000 KW, separate neutral terminal box shall be provided to mount three differential current transformers (CT). 3 Nos of phase side CTs shall be supplied by the Bidder in loose to mount it in the Purchaser Switchgear panel.

v. The neutral box arrangement shall be such as to permit easy access for C.T. testing and replacement

vi. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Purchaser's requirements to be intimated to the successful Bidder

vii. The cable box design shall be suitable for any type of cable termination kits available. Cable glands shall be double compression brass type.

viii. Terminal boxes shall have a degree of protection of atleast IP 55 for out door application.

ix. Unless otherwise approved, the terminal box shall be capable of being turned through 360^0 in steps of 90^0.

x. Terminals shall be of stud type & the terminal box shall be complete with necessary lugs, nuts, washers.

xi. The terminal box shall be capable of withstanding maximum system fault current for duration of 0.25 sec

Data:

Sr. No.	**Description**	**Unit**	**Particulars**
(a)	Type of motors (Main Motor)		Squirrel Cage
(b)	Supply System fault level	MVA	500
(c)	Rated Voltage	KV	11
(d)	No. of Phases and frequency		3 Phase, 50 Hz
(e)	Type of duty/designation		Continuous/S1

Sr. No.	Description	Unit	Particulars	
(f)	Method of Starting		Using VFD	
(g)	Class of insulation		F	
(h)	Ambient reference temperature	deg. C	45	
(i)	Temperature rise shall be limited to Class B Thermometer Winding resistance	deg. C deg. C	70 80	
(j)	Location		Indoor	Outdoor
(k)	Type of Cooling (IS:6362)		TEFC	TEFC
(l)	Degree of Protection		IP55	IP65
(m)	Terminations			
	(i) Short time current withstand for terminal box	kA(rms)	25	
	(ii) Duration	Sec	0.25	
	(iii) Dynamic current withstand for terminal box	kA(peak)	31	
	(iv) External cable details • Type		11KV, UE, Al. Cond. XLPE	
	(v) Earthing Conductors • Material • Size	 Mm x mm /SWG	 GI Main motor – 50 x 10	
(n)	Color shade of paint		Light grey, Semi glossy Shade: 631 of IS: 5	

8.6.14 Induction Motor (Submersible Pump & mixer)

Performance and Characteristics

a) The submersible motor shall conform to IS: 9283:1979 and the submersible cable shall conform to clause no. 4.4 of the IS: 9283:1979. The motors shall be suitable for operating on a 415 V, 50 Hz, 3 phase, Ac supply. Pump motor shall be of the squirrel cage submersible type, protected to IP 68. Motor for submersible pump shall be capable of startup and operation in the event of a completely flooded wet well. Motor cooling for submersible pump must be achieved by a cooling jacket, using the pumped media to cool the motor. The pump impeller must be equipped with a system to ensure a pumped flow of liquid through the cooling jacket and also incorporate a device to prevent the liquid channels from

blocking with hair and foreign material. This motor shall be capable of starting 10 times per hour. The insulation class of motor winding shall conform to class F/H as specified in the pump or mixer specification. Additionally, the specific requirements mentioned in the following clauses shall also be met. The motor shall be of IE-2/IE-3 energy efficient type.

b) Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the following supply conditions:

(i)	Variation of supply voltage from rated motor voltage	±10%
(ii)	Variation of supply frequency from rated frequency	±5%
(iii)	Combined voltage and frequency variation	±10%

The starting current of motor shall not exceed 300% of rated full load current for soft starter starting and 600% of rated full load current for DOL starting, under any circumstances.

Motors shall be suitable for full voltage direct-on-line starting or soft starter starting.

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperatures, when the supply voltage is in the range 85% of the rated motor voltage to maximum permissible voltage.

The locked rotor current of the motor shall not exceed 600% of full load current (subject to tolerance as per the applicable standard) unless otherwise specified.

Motors shall be designed to withstand 120% of rated speed for two minutes without any mechanical damage, in either direction of rotation. The motor vibrations shall be within the limits specified in applicable standard unless otherwise specified for the driven equipment.

Except as mentioned herein, the guaranteed performances of the motor shall be met with tolerances specified in applicable standard, IS: 9283-1979.

Motor insulation shall conform to Class F/H as specified in the pump or mixer specification and the maximum temperature rise shall be limited to class B. The motor windings shall be protected with a waterproof material and shall incorporate a thermal sensor in each phase to safe guard against high winding temperatures. The thermal sensor shall be connected into the control circuit of the starter and signals taken for continuous monitoring of winding temperatures. The motor shall incorporate a cut out device to detect the presence of any liquid in the motor enclosure, in the form of non resetting moisture switch. The terminal connections for the power and protective circuits shall be housed in a completely sealed and water proof junction box, complete with all external corrosion resistant cable glands. The pump units shall be provided with power and protection circuit cables of sufficient length to reach from the motor junction box to the local isolator located at the panel floor level.

Protection against increase in stator winding temperature bearing temperature, leakage in stator housing and terminal box shall be provided. Minimum three number thermistors are to be provided to sense the stator winding temperature. Sensors are to be provided to detect if leakage of sewage into the oil housing is above 30 % concentration.

Bimetallic thermal switch to trip the motor against increase in temperature shall be provided.

The power rating of the motor shall be larger of the following:

(i) 115% of the power input to the pump at duty point at a speed corresponding to the frequency of 49 Hz.
(ii) Maximum Power input while operating single pump corresponding to the speed of 50 Hz.

Motor shall be offered for routine and type tests in accordance with IS: 4029 and IS: 325 at the manufacturer's works.

8.6.15 Submersible Cable

(a) The submersible cable shall conform to clause no. 4.4 of the IS: 9283:1979. The power cable shall be PVC insulated and PVC sheathed, flexible, 3.5 core flat type. The size of the conductor shall be adequate for continuous use under water and air. The half core shall be used for earthing.

(b) The control cable shall be PVC insulated PVC sheathed, flexible, flat type and shall be adequate for continuous use under water and air. The control cable for stator winding temperature sensor (Thermistors) 3 core x 2.5 sq. mm copper conductor and for bimetallic thermal switch 2 core x 2.5 sq. mm copper conductor shall be provided.

(c) In case a joint is required to be made between the lead cable supplied with the motor and the user's cable connectors, a detailed procedure of cable jointing to make a watertight joint shall be provided by the manufacturer.

(d) The size of the conductor and length of cable should be suitably selected so that the voltage drop at motor terminals does not exceed 3 percent of the rated voltage.

(e) Cable Glands shall generally be of the mechanical double compression hexagon type Earth continuity of brass glands shall confirm to BS 6121 / EN 50262. This may be achieved by the rigid clamping of the armour within the gland and the intimate contact between the threaded components of the gland and the equipment.

(f) Each gland shall be installed complete with proprietary earth tag providing a ready means of connecting a flexible strand or strip earth bond to the gland at any position around the gland in relation to the associated apparatus. Adequate earth continuity shall be assured between the earth tag, the gland and the armour wires of the cable where applicable.

(g) Each gland shall be installed complete with a proprietary non-ferrous lock nut to secure the gland body to the equipment where the entry hole is plain, i.e. not tapped.

(h) Earthing

Earthing of the motor shall be done in accordance with the relevant provisions of IS: 3043:1966. For the purpose of earthing these motors, earthing connection may be made to discharge pipe. All the materials and components for the motors shall be suitable for application in respect of corrosion resistance and mechanical performance continuously under water.

8.6.16 Insulation

(a) Any joints in the motor insulation such as at coil connections or between slot and end winding sections, shall have strength equivalent to that of the slot sections of the coil.

(b) The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The tropicalising treatment shall be as per the applicable standard.

(c) The stator winding shall be made from high conductivity annealed copper conductor, PVC insulated winding wires conforming to IS: 8783:1978 for wet type motors. The stator winding shall be of high conductivity annealed copper enameled insulated wires conforming to IS: 4800 (Part-VII):1970 for dry type motors.

8.6.17 Temperature Rise

The temperature-rise test of the motor shall be carried out with the motor coupled to the suitable pump as per relevant standard.

8.6.18 Constructional Features

The motor shall be suitable for continuous use in fully or partially submerged condition. A built in cooling system must allow the motor to operate continuously at its rated output regardless of whether the electric motor is submerged or not, by providing either external or internal cooling arrangement. For Dry pit installation submersible motors external cooling jacket shall be filled with coolant, such as glycol water.

8.6.19 Terminal Box

Terminal box shall be of weather proof construction to eliminate entry of water and dust.
The terminals shall be of the stud type with necessary plain washers, spring washers and check nuts. They shall be substantially designed for the current carrying capacity and shall ensure ample phase to phase and phase to ground clearance.

8.7 Sluice Gate & Weir Gates

8.7.1 Cast Iron Gate:

(a) Design Requirements and Construction Features

The construction of sluice gates shall be in accordance with the specification and generally as per IS: 13349. All sluice gates shall be of the rising spindle type.

(b) Frame

The frame shall be of the flange back type and shall be machined on the rear face to bolt directly to the machined face of the wall thimble.

(c) Seating Faces

Seating faces shall be made of full width, solid section; dove-tail strips of stainless steel. They shall be secured firmly by means of counter sunk fixings in finished dove-tail grooves in the frame and slide faces in such a way as to ensure that they will remain permanently in place, free from distortion and loosening during the life of the sluice gates.

(d) Wedging Devices

Sluice gates shall be equipped with adjustable side, top and bottom wedging devices as required providing contact between the slide and frame facing when the gate is in closed position.

(e) Lifting Mechanism

(i) Sluice gate shall be operated through suitable lifting mechanism which shall incorporate suitable gearing if required, to keep the torque requirement within 7 kg.m.

(ii) Lifting mechanism shall incorporate a strong locking device suitable for use with a padlock or padlock and chain.

(iii) Lift mechanism shall be provided with a suitable position indicator to show the position of the gate at all times.

(f) Wall Thimbles

The cross section of the thimble shall have the shape of the letter 'F'.

(g) Lifting Lugs

Lifting lugs shall be provided for all gates.

(h) Flush Bottom Seal

(i) When sluice gates are provided with flush bottom seals, the wedging device and facing along the bottom edge of the slide and frame shall be omitted.

(ii) A solid square cornered, resilient rubber seal shall be provided on the bottom facing of slide. The seal shall be securely fastened to the bottom face of the slide by a retainer bar and corrosion resistant metal fasteners. The top surface of the bottom facing of frame shall be flush with invert of the gate opening. Bottom facing of the slide shall be accurately machined to make contact with the seal when the slide is closed.

(i) All the sluice/Weir gates in TSPS/ISPS, STP Headworks (Screen channel & grit mechanism area), Primary and Secondary Clarifier distribution & inlet and outlet control area, All Bypass/Weir gate arrangement, Rapid Sand Filter area and Hydropower Screw turbine area and others shall be provided with permanently fixed electric actuator under this contract.

(j) Two nos. Portable type of Electric actuator and One no. of Battery operated actuator for emergency operation shall be provided for opening and closing of sluice gates, so that the closing and operation time shall be maximum of 10 minutes only for Chlorine Contact Tank and Aeration Tank area.

(k) The material of construction of sluice Gate shall be as follows:

S. No.	Component	Material
(i)	Wall Thimble	Cast Iron : IS 210 Gr. FG 200
(ii)	Frame and Slide	Cast Iron : IS 210 Gr. FG 200
(iii)	Seating faces	Stainless Steel : ASTM Countersunk fixing A276 type 316
(iv)	Wedge	Stainless Steel : ASTM A743 CF8M or SS316
(v)	Stem	Stainless Steel: ASTM extension A276 type 316
(vi)	Stem nut	Stainless Steel : ASTM A743 CF8M
(vii)	Stem Coupling	Stainless Steel : ASTM A276 type 316
(viii)	Fasteners, anchor	Stainless Steel : ASTM bolts and nuts A276 type 316
(ix)	Lifting mechanism, Pedestal gear house cover and stem guide	Cast Iron : IS 210 Grade FG 200
(x)	Lift nut	Bronze : ASTM B 148 (CA952, CA954 or CA958)
(xi)	Stop nut	Bronze : ASTM B 148 (CA952, CA954 or CA958)

8.7.2 Modulating Sluice Gate:

The construction of the gates shall be in accordance with the specification and generally shall be as per IS: 13349-1992.

Wall thimble mounted Sluice gates shall be used for isolation of flow from a chamber to a closed conduit. It shall be suitable for modulation application.

Salient Features:

- It shall be of flange back frame gate suitable for mounting on the face of a Cast iron Wall thimble using studs and with a gasket between gate frame and wall thimble flange.

- Wall thimble shall have cross section “F” and depth of 300 mm. Gates having square / rectangular opening to be provided with thimble having square/ rectangular opening aperture with square / rectangular flange for gate frame mounting.

- It shall have Square/Rectangular shaped natural rubber Gasket with predrilled holes for positioning in between machined face of wall thimble flange and frame flange.

- It shall have open top frame provided with short length extension guides to support ½ vertical height of the slide when the slide is in full open position.

- Frame will be provided with liners for modulating duty application.

- Frame specially designed to permit front access for tightening of thimble mounting nuts so as to enable mounting of gates side by side or near corners.

- Rigid shutter designed to withstand the applicable water head. Shutter to be provided with cast integral pocket to house the stem-connecting block, which connects the spindle to the shutter for up and down operation.

- Seat facing fitted on machined plain surface of frame and shutter-using counter sunk screws for better fitments.

- The type of bottom closing offered is Flush bottom closing (FBC). In flush bottom closure gates, sealing to be metal to rubber for bottom side and metal-to-metal on balance three sides.

- Adjustable type individual side wedging arrangement for gates meant for seating water head application and adjustable type individual side as well as top & bottom wedging arrangement for gates meant for unseating water head application.

- Adjustable Channel type stem guide brackets in requisite quantity to prevent buckling of spindle in event of over-closing of gate.

- Rising stem / spindle to suit the distance between centerline of gate opening and top of operating platform as stated below in price schedule. The spindle shall be provided with square / trapezoidal threading with the threaded length being approximately 400mm more than the height of waterway opening.

- Spindle couplings to connect multiple stem / spindles in case the maximum length of one-piece stem / spindle exceeds 4.5 to 5 meters resulting into provision of more than one stem / spindle.

- Rising spindles are provided with Stem cover of Polycarbonate tube to protect spindle threads from effect of dust, dirt and weather.

- Rising spindles are provided with gate opening indicating arrangement to indicate the position of shutter.

- Provision of safety stop nut on spindle to prevent the chances of over-closing of gate, which may otherwise damage either the spindle or the lifting platform.

- Lift mechanism mounted on separate platform above gate frame so that gate operating thrust comes on to the platform.

- Operation of gate by means of electric lift mechanism comprise of pillar mounted Electric Actuator with manual override unit. These actuators should have an inbuilt with local control push buttons and suitable for modulating application.

SI.No.	Part Description	Materials of Construction
a	Frame & Shutter	CI IS: 210 Gr. FG 200
b	Wall Thimble	CI IS: 210 Gr. FG 200
c	Seating Faces & Counter Sunk Fixing	Stainless Steel ASTM A240 type 316
d	Wedging Device (with SS 304 Linings)	CI IS: 210 Gr. FG 200
e	Stem, Stem Extension & Coupling	Stainless Steel ASTM A276 type 316
f	Stem Block	Stainless Steel ASTM A743 CF8M
g	Fasteners, Anchor Bolt, Studs & Nuts	Stainless Steel ASTM A276 type 316
h	Lifting Mechanism, Pillar, Head Stock	CI IS: 210 Gr. FG 200
i	Stem Guide	CI IS: 210 Gr. FG 200
j	Stem Guide Bracket	Structural steel
k	Stem cover with Indicating Arrangement	Polycarbonate Tube
l	Lift Nut	Bronze IS: 318 Type LTB-2
m	Stop Nut	Bronze IS: 318 Type LTB-2

8.7.3 Mechanically Operated Stop logs

The construction and general design of Aluminum Stoplogs shall be in accordance with the specifications mentioned here under. They shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The stoplogs shall be capable of performing the isolation duties in waste water treatment plant and pumping stations for those applications where the side water depth is at least 300 mm less than the height of stoplogs.

The stoplogs as well as stoplog frame shall be made of extruded sections and not fabricated so as to keep welding to minimum.

The Stoplogs shall be designed for seating water pressure equal to the height of the top most log.
The Stoplogs shall have an on-seating leakage rate of not more than 1.25 litres / minutes / meter length of sealing perimeter.

The Stoplogs shall be supplied along with all accessories such as Stoplogs, lifting system, storage rack etc and miscellaneous items like fasteners, gaskets, anchor bolts etc. required to erect and install these items.

Each Stoplog shall be manufactured as detailed hereunder and shall be supplied duly tested as per requirement. The Stoplog assembly shall be supplied as a factory assembled unit and shipped to site as a ready to install unit.

This assembly shall be uncrated at site and installed as complete assembled unit without stripping down into components. This is to ensure that the performance integrity of the stoplogs remains as factory tested and supplied condition, thus minimizing the influence of the installation process to achieve optimum performance at site after installation.

(a) **Constructional Features**

The constructional features and details of components of the required stoplogs are to be as under:

The stoplogs shall be made of extruded section of Aluminium material of grade 6061 T-6 and having minimum thickness of 5 mm. The sections used shall have adequate strength to prevent distortion during normal handling, installation and while in service.

The extruded stoplogs section shall be sufficiently rigid to withstand the designated water head. Maximum bending stress shall not exceed 7600 PSI at the maximum operating head.

The extruded stoplog section shall be designed for adequate and prompt drainage while removal.

The stoplogs shall be provided with lifting pins to enable lifting of stoplogs using mechanically operated lifting beam.

The total height of stacked stoplogs shall be approximately 300 mm above the maximum height of water.

The stoplog sectional height shall not be less than 250 mm and not more than 1250 mm so as to ensure that minimum sectional pieces are provided to achieve the required total height.

Stoplogs suitable for lifting manually using lifting rods should not weigh more than 50 kgs to enable 2 persons to lift them and transfer to storage rack. Stoplogs suitable for lifting using mechanically operated lifting beam, which can engage / disengage automatically with lifting pins provided on logs, shall be so designed that the total lifting load does not exceed 1000 kgs including the water pressure acting on the stoplogs.

The aluminum stoplogs shall be provided with minimum 120 micron thick coat of suitable epoxy paint to prevent oxidation of aluminum material.

(b) Stop log Frames

The stoplogs frames shall be made of extruded section of Aluminum material of grade 6061 T-6 and having minimum thickness of 5 mm. The sections used shall have adequate strength to prevent distortion during normal handling, installation and while in service.

The stoplogs frames shall comprise of bottom invert section and two vertical side guide section for housing the stoplogs. The frames shall be suitable for embedment in two parallel walls on sides and in floor invert at bottom.

The vertical sides of the frame shall extend up to the top of the operating platform to facilitate in removal and insertion of stoplogs. For lengths above 3 meters the vertical side guides can be provided in sectional construction.

The aluminum frame shall be provided with minimum 120 micron thick coat of suitable epoxy paint to prevent oxidation of aluminum material.

(c) Seals

The stoplogs sealing arrangement shall comprise of continuous resilient seal along the bottom and both sides to restrict leakage in accordance with the requirement listed in this specification. The resilient seals shall be of EPDM or Neoprene rubber as per ASTM D2000. The side seals shall be mechanically retained and all the seals shall be easily replaceable. Seals fixed by gluing will not be accepted. The fasteners used shall be of stainless steel material as specified.

(d) Lifting Beam

Lifting beam shall be provided to insert and pull out the stoplogs using an electric hoist arrangement. If the hoisting weight of stoplog is over 50 kgs then suitable provision for handling the stoplogs with the lifting beam should be provided by the contractor. The lifting beam shall be designed to automatically engage with an installed stoplog and lift the same out of frame. The lifting beam also shall have arrangement to disengage the stoplogs by an operator standing on the platform. One lifting beam shall be provided for stoplog having same / equal width in the plant.The lifting beam shall be constructed of Carbon steel material with epoxy painted and shall be designed to lift a load of minimum 1500 kgs.

(e) Storage Rack

A movable storage rack shall be provided to house the stoplogs and lifting beam when they are not in use. The storage rack shall be constructed of Stainless Steel material. The storage rack shall be so designed that the resilient seals of the log shall not remain under compression during storage.

The material of construction for various components shall be as under:

Component	**Material**
Stoplogs & Frame	Aluminum alloy 6061 T-6
Resilient Seals	EPDM ASTM D2000
Rubber seal retainer bar	Stainless Steel ASTM A 240 type 316
Assembly bolts, nuts and fastener	Stainless Steel ASTM A 276 type 316

8.7.4 WEIR GATES

The downward opening weir gates shall be manufactured from Cast Iron and shall be Flange back type suitable for wall mounting and generally manufactured in line with provisions of AWWA C-560 / IS 13349 with improvements as desired and specified hereunder for weir application.

The weir gates shall be capable of performing continuous weir duty in plant and shall be so constructed that there is no undue wear or deterioration during its operative life and so designed that the maintenance is kept to a minimum.

The weir gates shall be designed for water tightness at any level of opening for off-seating pressure equal to depth of shutter. The weir gates shall have off-seating leakage rate of not more than that permitted under AWWA-C560 / IS 13349.

All the weir gates shall be shop tested to verify the leakage performance at operating head, torque tested at operating head to verify the suitability of actuating mechanism and PMI tested to verify the correctness of the material used. This testing will be done in presence of client / client representative or approved third party inspection agency.

The weir gates shall be rising spindle type and the operation shall be by means of Manual / Electric operating mechanism.

The weir gate shall be supplied along with all accessories such as gates assembly, gasket between wall and gate assembly, studs and nuts for mounting on wall, stem connecting block, spindle, spindle couplings, spindle guides, pedestal, operating mechanism as required, gate opening indicating arrangement and required anchor bolts and fasteners for stem guides and pedestal.

The main gate assembly comprising of frame, guides and shutter will be supplied as a factory assembled unit and shipped to site as a ready to install unit on the wall. This gate assembly will be uncrated at site and installed as complete assembled unit without stripping down into components. This is to ensure that the performance integrity of the weir gates remains as factory tested and supplied condition, thus minimizing the influence of the installation process to achieve optimum performance at site after installation.

(a) Constructional Details :

The weir gates shall be manufactured generally as per provision of AWWA C-560 / IS-13349 with suitable changes for weir application. The constructional features and details of components of the required gates shall be as under:

(b) Gate Frame

The gate frame will be made from cast iron and shall be sufficiently rigid to withstand the designated water head. The gate frame shall be flange back type to suit the designed head and site condition. Back flange of the gate aperture frame to be precisely machined flat and drilled to engage with the face wall. A rubber gasket will be provided between the wall and the gate for ease in future dismounting of the gate for repairs / replacement and seal any leakage between the flange of frame and the wall. The gate frame of these sluice gates shall either be self contained type or non self contained type depending upon site

requirement. In case of non self contained gates the frames shall be without yoke at their top. In case of self contained gates the frames shall have extension guides of requisite length and shall be provided with a yoke at their top. The length of guides shall be sufficient to engage at least half the overall vertical height of door when the gate is fully lowered to open and shall be in accordance with the relevant provisions of AWWA C-560 / IS-13349.

(c) Gate Slide / Shutter/ Door

The gate slide / shutter will be made from cast iron and shall be sufficiently ribbed to withstand the designated water head. The gate slide / shutter will be provided with integral pocket to house the thrust nut used to connect the stem with the slide.

(d) Seating/Sealing Faces:

Seating face shall be of Stainless steel. The seating / sealing faces on door shall be secured in place using taper screws which cannot be mechanically removed after fitting on facings. The taper screws adopted for facings shall be of same material as that of the seat facings.

To enable continuous sealing at any level of opening of the downward opening weir gate so as to achieve precise level control, the full face of the shutter will be fitted with specified seating / sealing faces and the sealing faces on shutter will always be in full face contact with corresponding metal / resilient sealing arrangement mounted on frame perimeter.

The mating seating/sealing faces on the gate frame and door shall be precisely finished for proper contact. They should be so finished that the clearance or gap, if any, between the mating sealing faces does not exceed 0.1mm at any level of weir gate opening.

(e) Manual Gate Operating Headstock/Lift Mechanism

The operating headstocks shall be designed in such a manner as to permit the gate operation by a single Person under the specified maximum operating head with an effort of less than 18 Kgs. on the crank /hand-wheel.

The headstock may be ungeared or geared type and the geared headstock may be either of single speed or of double speed, as might be necessary to make it convenient for one person to open or close the gate as fast as practicable. Two speed headstocks shall be supplied with gates requiring higher hoisting capacities. In this type of headstock the low speed is meant for crack opening the gate when the effort required to open the gate is maximum and the high speed is meant for further faster opening after the gate is crack opened.

Geared headstock shall be supplied with easily removable crank handle or handwheel with a radius not exceeding 375mm.

All the gears of geared headstock shall be kept completely encased in cast iron housing to protect them from damage, dirt, dust, water etc. and other atmospheric effects and thus ensure their smooth operation. Grease Nipples shall be provided at proper places for lubricating with grease.

Headstock meant for mounting on operating platform shall be supplied with a pedestal/floor stand to provide a convenient operating height of approximately 900 mm. The pedestal of the headstock shall be provided with a covered window opening to enable cleaning and greasing of stem threads.

(f) Lifting Spindle/Stem

The sluice gates shall be supplied with Rising type lifting spindles/stems. The stem shall be provided with acme / square threading, length of threaded portion being about 400 mm more than the height of waterway opening. This much extra length is required to allow for a minor variation of approximately 100mm on either side of the specified height of operating platform.

The design of stem will be done as per the provision in AWWA C-560 / IS-13349.

(g) Stem Block/ Thrust Nut

The rising type stem shall be connected to the door through a stem block/thrust nut housed in a ribbed pocket cast integral with the door. The bottom end of stem shall thread into the stem block and is locked in place by a set screw to prevent the stem from unscrewing. The Stem block shall be cast bronze or Gunmetal.

(h) Safety Stop Nut

The stem shall be provided with a safety stop nut to prevent the chances of over opening of gate which may otherwise result into spindle unscrewing from the operating nut and falling of shutter. The stop nut shall be furnished with a set screw for setting it in a fixed position after the gate is installed. Upon installation the safety stop nut should be set in such a way that its bottom remains about 1 to 2 mm away from the top of headstock, in gate open position. In case of stainless steel stem, the stop nut shall also be of stainless steel material of the same grade.

An adjustable stopper arrangement will be provided on the frame and this stopper will engage with corresponding arrangement on shutter so as to prevent over closure of the shutter.

(i) Stem Coupling

For ease in transportation and handling, maximum length of one piece stem shall be restricted within 5 meter length. Where the stem are required to be furnished in more than one piece, threaded stem couplings shall be furnished to interconnect different sections of the stem. The couplings shall have provision for pinning after inserting in the threaded end of the stem. In case of stainless steel stem, the couplings shall also be of stainless steel material of the same grade.

(j) Stem Guide Bracket

Longer stems shall be provided with sufficient number of stem guides to prevent buckling of stem. The stem guide bracket to be provided shall be Adjustable Centre Type - wherein a separate stem guide is bolted on to the wall bracket. The stem guide shall be adjustable in the slots on wall bracket in a direction perpendicular to the face of wall. Wall bracket should also offers minor adjustment in the

direction parallel to the wall. The stem guides shall have machine bored split journals to facilitate erection. The journal shall be lined with brass/gunmetal bush.

(k) Pipe Hood For Stem

A Pipe hood shall be provided on the top of headstock in case of rising spindle/stem gates to cover the spindle threads for protection against damage, dirt, dust, water etc. It shall be made of transparent fracture resistant polycarbonate material. The pipe hood shall have vent holes to prevent condensation.

(l) Gate Opening Indicating arrangement

Gate opening indicating arrangement shall be provided to indicate the position of the shutter. This shall comprise of scale mounted on the pipe hood and an indicator nut mounted on the rising spindle to show the extent of the opening and closing. The minimum scale graduation shall be 25 mm.

MATERIAL OF CONSTRUCTION:

The material of construction for various components shall be as under:

Component	**Material**
Gate frame, Shutter	Cast Iron to IS:210 Gr FG 200
Headstock, Stem Guides, Stem Guide Bracket	Cast Iron to IS:210 Gr FG 200
Seating faces,	Stainless Steel ASTM A 240 type 316
Rubber Seals	EPDM Rubber to ASTM D 2000
Rubber seal retainer bar	Stainless Steel ASTM A 240 type 316
Assembly bolts, nuts and fastener	Stainless Steel ASTM A 276 type 316
Stem & Coupling	Stainless Steel ASTM A 276 type 316
Yoke	Steel Epoxy painted
Stop nut, Thrust nut and Lift nut	Gunmetal / Phosphor Bronze

8.8 Trash Racks for TSPS

8.8.1 Scope of Supply

The scope of supply shall include Trash rack system with all accessories and appurtenances, including, but not limited to:

- Removable J-type Trash racks which are installed by lowering the same in side guide channels or grooves provided in the trash rack channel so that the trash racks may be readily removed by lifting them through guides.

- Lifting Arrangement by one number electric hoist shall be provided for each manually raked screen and the same shall be permanently attached to screen.

- Rakes for manual cleaning after bringing them on cleaning area.

8.8.2 General

One trash racks will be installed before mechanical operated screen, with one working. The structural arrangement of racks generally consists of equally spaced trash rack vertical bars supported on horizontal members connected to end vertical members, which sit in the grooves of guide rail. The trash rack will have J-type structure at the lower end for support and for collection of screened material that will extend for minimum 600 mm from vertical bars. Hook will be provided at the upper end for lifting of the Trash Rack by Hoist. The minimum thickness of the bars will be 10 mm, width 50 mm it should preferably be fabricated from flats with rounded edges. A platform at suitable/finished ground level shall be provided to manually clean the trash rack by raking and by water jetting arrangements for collection of screenings in portable screenings container.

All the screens shall be provided with 2 sets of SS 304 cleaning rakes with appropriate grip handle.

8.8.3 Aperture Size

The screen apertures shall be sized to capture particles of 20 mm and above size. The clear spacing between the bars will be 20 mm.

8.8.4 Inclination of Trash Racks

Racks will be installed on guide rails which will be kept in vertical position at 90 degrees.

8.8.5 Velocity through racks

Velocity up to 1.2 m/s at peak flow and 0.6 m/s at average flow on the gross area of racks may be permitted.

8.8.6 Required Downstream Water Level

Contractors should state the maximum and/or minimum allowable water levels downstream of the screen in order to pass the required flow.

8.8.7 The Material of Construction

The material of construction of the trash rack equipment shall be in grade 316L stainless steel.

8.8.8 Manual Raking and Screenings Removal

Suitable arrangement should be made for cleaning the racks manually at regular intervals after removing the trash rack installed in channel through guide rail. The frequency of cleaning of the racks would depend upon the rate of accumulation of trash. Not more than 33 percent of the trash rack area should be allowed to clog the racks at any time. The raked screenings will be conveyed through screw conveyor and then collected in portable screenings container.

8.8.9 Structural Requirements

Structural connections in the trash rack should be designed and provided for the failure load of the structural members. All flats should be welded to the intermediate horizontal members and the top and

bottom horizontal members for better resistance to vibrations and to avoid stress concentration at the external edge of the groove. The vertical member of the trash rack should be so arranged as to apply the load near the inner part of the rack guide. The guides of the trash racks should be so proportioned that the side members get lateral support from guides after deflection to take up the clearance in the slots.

8.8.10 Access

Safe access shall be provided to all trash racks when hoisted to allow for cleaning, inspection and maintenance activities.

8.8.11 Corrosion Resistance

All metal parts of the screen equipment that are in contact with the sewage shall be constructed of a suitable grade of corrosion resistant stainless steel 316 L.

8.8.12 Working Stress and Design

The design of all parts shall ensure that under the most onerous of conditions they will not be damaged or corroded.

Any joint that will need to be dismantled during maintenance shall be made by anti-corrosion type fasteners.

All spare parts shall be fully interchangeable with the original part. If the spare part is unavailable due to cease of production, the Contractor shall give notice to the Employer in writing, detailing the options available to the Contractor.

All parts shall be designed to minimize the risk of fire and consequential damage. All parts shall be designed to prevent the ingress of vermin, dust and dirt. All electrically live or moving parts shall be adequately guarded to prevent accidental contact.

8.9 Mechanical Coarse Bar Screen- TSPS

8.9.1 General

(a) The screen shall be installed in raw sewage inlet channel, and the screen shall be of multirake type with Mechanical cleaning and Auto Jam Removal. Inclined Bar screen at 75 degree and the minimum bar thickness shall be 12 mm with 50 mm width of the bar and 20 mm clear spacing between each bar.

(b) The screen shall be capable of performing the duties set out in this Specification. All the materials and sub-assemblies used shall be suitable for outdoor application. They shall be constructed so that maintenance is kept to a minimum.

(c) Ideally, any moving parts such as sprocket, bearings etc, should not be immersed in sewage. In case if immersed, the parts shall be of such materials that they require little or no maintenance. All lubricating points shall be conveniently accessible from the deck level.

(d) The screen shall be suitable for discharging 75% of the screened material lifted from the screen into the chute.

(e) The screen shall be designed such that in case of heavy accumulation of solids the same is to be removed gradually without overloading or damaging the screen bars or mechanism.

8.9.2 Frame work

The frame work of the screen shall be of robust construction with intermediate cross bracing. The lower ends and sides of the frame shall be grouted in concrete. Each screen shall have an independent canopy at the top for weather protection. Framework of screen shall be constructed of Grade 316 stainless steel and cross section with a minimum thickness 6 mm. Various parts fastened by welding or bolting shall be braced as necessary to insure a rigid structure. The side frames shall be minimum 6 mm formed to a channel profile. The bottom thickness shall be minimum 6 mm. The frame shall have support beams with U or C-profile minimum thickness of 6 mm on the front above the maximum water line. The Screen Frame shall be supplied in one piece, requiring no field assembly. Bars shall be supported from framework.

8.9.3 Screen bar assembly

Screen bar assembly shall be fitted across the screen chamber. Screen shall have a series of vertically oriented bars spanning the inlet channel and spaced as specified. Bars shall be sufficiently rigid to prevent vibrations in stream-wise and lateral modes and to withstand the maximum differential head that will occur with the screen totally blinded. Bars shall have tapered cross section to prevent jamming of screenings between bars. Bars shall have supports only at both ends.

8.9.4 Rake carriage

The design shall be multirake and the rake carriages shall comprise a stiffened frame work to which is attached replaceable rake tines. Rake carriage shall incorporate suitable devices to enable the rake to ride over any small obstacles wedged in the screen and automatically stop the drive motor in the event of the rake jamming against a large obstruction. There shall not be any mechanical damage resulting from obstruction wedged in the screen bars. The rake carriage shall always come to rest in a parked position with the rake above the sewage level. The raking tines shall have the tooth profile precision cut from a single continuous bar of enough thickness and depth to insure adequate stiffness and strength to cope with the specified duty cycle. The rakes shall run in guides on both sides to ensure engagement and clean the bars from the upstream side of the screen. The rakes shall be fabricated from stainless steel Grade 316L. The rake material, thickness of material, and capacity of rake is similar to the entire construction. The rake tines shall be suitable to accommodate bulky screenings.

Thickness of rake blade 10mm
Reinforcement profile 6 mm
Rake Side Plates 6mm

The screen shall be cleaned automatically through an adjustable timer. The rake lowered will clear screen bars at the beginning of a cycle and accurately engage with the screen bars at the bottom of the channel. The tine profile and rake motion shall be designed to elevate screenings to the discharge chute at deck

level and will not wrap around the tines or the stationary bars, and also will not fall back into the sewage flow during the cleaning cycle. The rake shall be suitable for elevating debris encountered at any level. Rake tines shall be replaceable.

Screenings transported to the top of the screen shall be discharged positively by means of a scraper mechanism to the discharge chute leading to a screw conveyor system. A scraper blade made of a combination of synthetic and other material shall be provided on the scraper. The rake tines shall then be retracted and the unit ready for the next cycle. Drive chains, chain guides, chain sprockets, bearings, and axles shall be fully replaceable without having to remove the screen from the channel.

8.9.5 Rake Lifting Mechanism

Lifting Mechanism Chains shall be roller type chains and made of SS 316L and SS 316 sprocket of high tensile strength and resistance to corrosion. The maximum force each chain take-up ~~is~~ shall be 112,000 Newton. Chain Pins shall be ~~a~~ of Stainless Steel construction and hardened.

Chain guide shall be securely fixed to the Screen frame for the full height of travel and shall not protrude into the flow. The type of chain guide, thickness of material and size is an L-Profile, Material Grade 316 Stainless Steel. Upper Bearings shall be of UCF Type or equal; housed bearings are grease-lubricated, mounted the Take-Up Frame assembly. No Bearings shall be submerged in the waste stream.

8.9.6 Inspection Platforms

An inspection platform shall be provided for periodic checking and maintenance of the drive and other critical parts. A ladder with handrails for access to this platform shall be fixed. Suitable hand rails shall be provided for safety on the inspection platform and also at deck level. The platform shall have holes to prevent from rain water accumulation.

8.9.7 Dead plate

SS316L dead plate extending from the top of the bars to the deck level shall be provided to ensure that screenings do not fall back. Dead plate shall be made of minimum 6 mm thick plate. The clearance between the tines and the dead plate shall not exceed 6 mm.

8.9.8 Discharge Chute

A discharge chute shall be of minimum 3mm thick provided for each screen to divert screenings discharged from the screen to a conveyor mechanism. The discharge chute shall be made of SS 316. The discharge chute shall be mounted at an angle of minimum 30 degrees. Panels are positioned on both sides to protect from splashing.

8.9.9 Covers

Covers which are easily removable shall be provided for easy maintenance. Covers shall be constructed of clear impact-resistant Polycarbonate material thickness 6mm and SS 316 thickness is 2mm to allow for visual observation during screen operation.

8.9.10 Driving Mechanism

The driving mechanism shall consist of a sturdy reduction gear unit driven through multiple 'V' belts or directly by an electric motor. Motor shall be mounted in such a way that the tension of the 'V' belts can be adjusted. A manually reset torque limiter shall be provided between the motor and gear unit, incorporating a limit switch to cut off the supply to motors in the event of an overload. The drive mechanism for the rakes shall incorporate a solid shaft constructed of SS 316.

8.9.11 Installation

The screen shall be designed for installing to either (a) pivot out of the channel, (b) be pulled out of the channel. Non-metallic side flaps seal the screen to the channel walls, or (c) The Screen shall be grouted in a wall recess and/or floor recess.

8.9.12 Gear Reducer

(a) The reducer shall be sized and selected with a minimum service factor of 2.0 times the motor nameplate horse power rating in accordance with applicable American Gear Manufacturer's Association Standards. The reducer shall have a life of 40,000 hours based on the motor name plate horse-power. The reducer shall have an efficiency of not less than 90% based on reducer input.

(b) All gear meshes shall be oil lubricated. All gears shall be provided with an oil reservoir for instant lubrication on starting. The gear reducer housing shall be provided with an oil level indicator and oil drain with necessary fittings.

(c) The gear reducer shall be of cast iron construction. The reducer housing shall also include suitable lifting lugs and external gear train inspection covers for each gear train. The gears shall be matched for maximum tolerance variation. The gear reducer shall be suitable to reduce the motor asynchronous speed to achieve the required speed of raking.

8.9.13 Control System

(a) The screening operation shall be carried out through adjustable timers which are adjustable at site for 0-60 minutes for interval between two operations.

(b) Control system for the conveyor shall be designed to achieve the following:

(i) Conveyor shall be started when any of the rakes starts it’s upwards travel.

(ii) Conveyor shall be stopped with a time delay (by adjustable timer) after rake is stopped.

(c) Weatherproof, lockable, emergency mushroom headed stop push buttons shall be provided near each motor for screen and screw conveyor, operation of stop push button and overload prevention for screen and screw conveyor shall be included in the control scheme.

8.9.14 Screw Conveyor with Compactor

Technical specifications of Screening Conveyor

The Screening Conveyor shall be Shaft less Screw Conveyor and applied for conveying the floating debris to the next facilities. The screening system shall be supplied with a shaft less screw conveyor that will be used to convey the screenings to the automatic screenings press and discharge system that compacts, dewaters and discharges the screenings through a chute to the screenings storage system.

Dumping of the screenings on to the duty/standby conveyor opening shall be with the automatic deflection plate, which shall be positioned towards the conveyor which is selected from the LCP/SCADA for the duty and automatically towards the standby if duty conveyor trips. Position of this deflection plate shall be interfaced with PLC.

Screening wash compactor shall be suitable for washing and compacting the floating waste coming out of the duty and standby shaft less screw conveyor in case of multiple screens, or directly from the screen in case of single screen installed in municipal waste water pumping station or treatment plant.

Shaftless screw conveyor shall be made of stainless steel of grade SS 304 hardened and shall incorporate shaft less spirals. Cover plates for shaftless screw conveyors shall be provided along the entire conveyor length to contain splatter. Conveyor trough covers shall be made from 5 mm of specified grade of stainless steel single piece formed sheet metal, not greater than 1000 mm in length, attached to the screw conveyor trough using toggle clamps. The cover shall also be of sufficiently tight fit to prevent the conveyed media from leaking out of the conveyors. A minimum 2.5 mm neoprene gasket of 50 durometer shall be applied with an appropriate adhesive to the mating surfaces of the trough covers.

Its structure shall have excellent durability to continuous running for long time. It shall be well considered of abrasion resistance, corrosion and vibration resistance. It should have a structure which is free from debris material clogging.
The spiral flighting for the shaft less screw conveyors shall be designed to convey material without a center shaft. The spiral flights shall be designed with stability to prevent distortion and jumping in the trough while operating at design speed and design capacity. The spiral flighting shall be Stainless steel of grade SS 316.

Shaftless conveyor trough liner material shall be an ultra-high molecular (UHMW) polyethylene with a minimum 12 mm thickness. There shall be two colored layers in the liner material to indicate wear. The liner shall extend the full length of the trough, covering the entire semicircular bottom portion of the trough. The liner shall be secured at intervals not to exceed 1000 mm, using specified stainless steel retaining clips of an approved design.

Screening wash compactor shall be made of stainless steel of grade SS 316. The wash compactor will receive the waste through inlet hopper and the waste shall be dropped in to the conveying zone of the compactor main body.

Screw and liner shall have rigid thickness for resisting corrosion and abrasion caused during carrying of debris. Its structure shall be designed not to invite biting and clogging. Casing shall be equipped with inspection port to the necessity as well as for cleaning convenience. Driving device shall have overload limiting switch for avoiding broken situation caused by overloading.

The conveying zone shall have perforations at the bottom so that the water coming along with the wet screening is dropped in to the dewatering trough. The dewatering trough will have a set of nozzles positioned upwards so that the screening particles chocking the perforations will be removed by the force of spray water. The construction of the dewatering trough shall be inclined towards the drive end so as to enable the flow of water to the drain hole provided with an elbow connection. The compactor main body shall also have a drain hole with an elbow connection.

In the conveying zone there shall not be any impeller wheel or any other mechanical breaking device. The breaking up of organic matter shall be done solely by water through an assembly of nozzles connected with solenoid valves in a special washing zone between the conveying and the compaction zone. The screening shall move towards the compaction zone by a shafted screw of a constant pitch connected to a drive shaft. This drive shaft shall be connected to the drive unit through axial and radial bearings. An electronic device shall operate the drive unit of the spiral in a forward reverse mode, separated by a stand still period. The time of forward and reverse operation as well as the stand still time shall be freely adjustable.

The non-drive end of the screw shall have the flight of reduced pitch in the compaction zone. For achieving better strength at non-drive end, the screw must be supported by wear bars connected to the wash press main body and reinforced with double flights of defined pitch.

An elephant trunk shape outlet tube shall be connected to the compactor body with a flanged connection. An elbow shall be provided at the flanged connection to carry the washed screening in the reduction tube. The reduction tube shall be divergent to ease the push of the washed screening upward in to the outlet tube. The end of the reduction tube shall have an elbow with discharge plate/chute to enable the collection of the screenings in bagging units or a container.

The Screening wash compactor shall remove the organic material by washing and compaction thus reducing the volume and weight by 50%.

The main body of Screening wash compactor shall have a material thickness of minimum 3 mm and the bottom of the compactor main body shall be perforated with 5 mm holes.

The screw flights of wash compactor shall have a minimum thickness of 10 mm and at the end of compaction zone, there shall be wear bars of 10 mm thickness bolted to the wash press main body/tube for easy replacement.

The elephant trunk shaped outlet tube shall be diverging to prevent the waste getting clogged. The connection of the outlet tube to the main body shall be flanged type. All the bend fittings (elbows) in the outlet tube shall be long radius design.

Frequency Inverter shall be provided for Forward-reverse-forward motion of the screw and as overload protection device.

The gearbox of screw conveyor and wash compactor shall be hollow shaft, parallel helical gear unit have a minimum service factor of 1.2, oil bath lubricated with oil sealing. The motor shall be of TEFC type

with minimum IP 55 protection & Class F insulation and be suitable for operation on 3 phase, 415V and frequency of 50 Hz. The drive shaft must be precisely machined and shall have radial and axial bearings.

The common control panel shall have IP 55 protection, painted with epoxy paint and shall be comprising of

- Mushroom head emergency stop.
- Overload relays for motor protection.
- Circuitry to operate the Screening conveyor and wash compactor with signal for start command from screen motor start and delay-timer based stop command after the screen motor stops.
- Selector switch to operate the Screening conveyor and wash compactor in Auto, manual and remote mode.
- Provision for suitable PLC circuitry shall be provided in case requirement of connectivity with SCADA system.

The Screw conveyor and wash compactor shall be supplied factory assembled and duly tested at manufacturer's works before dispatch. Upon receipt at site these shall be installed resting on the channel floor and mechanically or chemically anchored on to the platform in a way that there are minimum chances of misalignment.

Material of Construction

Screw	SS 316
Screw trough	SS 304
Screw cover	SS 304
Liner	Ultra-High Molecular Polyethylene (UHMPE)

Accessories

Anchor bolts and nuts	1 set
Special tools	1 set
Flexible joint for inlet and outlet	1 set
Liner (for spare)	1 set

8.9.15 Portable Screenings Container

Portable screenings containers made of galvanized steel shall be provided to store the screenings until time of pick up. Minimum two Screenings Containers shall be provided at the screening chamber. The container shall have capacity of approximate 2.0 cum and shall be of a convenient height to permit the discharge of screenings directly into the container without having to transfer the screenings manually. The containers shall have hinged covers and their design shall permit their being lifted by an overhead hoist or packer truck. The container will have four wheels each of minimum 40 cm diameter, Tyre type. The maximum height of container including wheels shall be 66 cm. The sides shall be constructed of 12 gauge steel. The bottom of container shall be made of 5 mm plate steel. The containers shall be reinforced with 50 mm x 50 mm x 5 mm angle.

8.9.16 Automatic Jam removal system

The screen shall have automatic electronically controlled Jam removal facility to ensure smooth operation without damaging the main equipment.

8.9.17 Motors

Motors shall be squirrel cage type conforming to IS 325. The Drive Motor shall be controlled by a Full Voltage Reversing Motor Contactor mounted on a Back Panel to be mounted in an Enclosure or MCC (Motor Control Center) in the main Panel. The power rating of motor shall be at least 125% of maximum power requirement. The other features of motors shall be as follows:

(i) Type of duty : Intermittent (S4)/Continuous (S1) based on manufacturer's design
(ii) Method of Starting : DOL
(iii) Class of insulation : F (Temperature rise limited to class B)
(iii) Type of enclosure : TEFC
(iv) Degree of protection : IP 55

(a) The material of construction of Mechanical Raked Screen shall be as follows :

S. No.	Component	Material
(i)	Screen	Stainless steel SS316L
(ii)	Frame (Side and Bottom Portion)	Stainless steel SS316
(iii)	Raked tines	Stainless steelSS316L
(iv)	Fasteners including Anchor bolts	Stainless Steel : 316L
(v)	Screen canopy	Stainless Steel: SS316L
(vi)	Chutes	SS316

8.10 Mechanical Fine Bar Screen-STP Inlet

The screen shall be installed in inlet channel to grit chamber, and the screen, shall consist of continuously moving perforated stainless steel panels. Inclined Bar screen at 45 degree and the minimum bar thickness shall be 3 mm & Width 3 mm. Clear bar spacing shall be 6 mm for the fine screens. Bar cross section shall be trapezoidal.

8.10.1 Frame work

The frame work of the screen shall be of robust construction with intermediate cross bracing. The lower ends and sides of the frame shall be grouted in concrete. Each screen shall have an independent canopy at the top for weather protection. Framework of screen shall be constructed of Grade 316 stainless steel and cross section with a minimum thickness 4 mm. Various parts fastened by welding or bolting shall be braced as necessary to insure a rigid structure. The side frames shall be minimum 4 mm formed to a channel profile. The bottom thickness shall be minimum 4 mm. The frame shall have support beams with U or C-profile minimum thickness of 4 mm on the front above the maximum water line. The Screen

Frame shall be supplied in one piece, requiring no field assembly. Bars shall be supported from framework.

8.10.2 Screen bar assembly

Screen bar assembly shall be fitted across the screen chamber. Screen shall have a series of vertically oriented bars spanning the inlet channel and spaced as specified. Bars shall be sufficiently rigid to prevent vibrations in stream-wise and lateral modes and to withstand the maximum differential head that will occur with the screen totally blinded. Bars shall have tapered cross section to prevent jamming of screenings between bars. Bars shall have supports only at both ends.

8.10.3 Rake carriage

The design shall be multirake and the rake carriages shall comprise a stiffened frame work to which is attached replaceable rake tines. Rake carriage shall incorporate suitable devices to enable the rake to ride over any small obstacles wedged in the screen and automatically stop the drive motor in the event of the rake jamming against a large obstruction. There shall not be any mechanical damage resulting from obstruction wedged in the screen bars. The rake carriage shall always come to rest in a parked position with the rake above the sewage level. The raking tines shall have the tooth profile precision cut from a single continuous bar of sufficient thickness and depth to insure adequate stiffness and strength to cope with the specified duty cycle. The rakes shall run in guides on both sides to ensure engagement and clean the bars from the upstream side of the screen. The rakes shall be fabricated from stainless steel Grade 316L. The rake material, thickness of material, and capacity of rake is similar to the entire construction. The rake tines shall be suitable to accommodate bulky screenings.

Thickness of rake blade	10mm
Reinforcement profile	4 mm
Rake Side Plates	6mm

The screen shall be cleaned automatically through an adjustable timer. The rake lowered will clear screen bars at the beginning of a cycle and accurately engage with the screen bars at the bottom of the channel. The tine profile and rake motion shall be designed to elevate screenings to the discharge chute at deck level and will not wrap around the tines or the stationary bars, and also will not fall back into the sewage flow during the cleaning cycle. The rake shall be suitable for elevating debris encountered at any level. Rake tines shall be replaceable.

Screenings transported to the top of the screen shall be discharged positively by means of a scraper mechanism to the discharge chute leading to a screw conveyor. A scraper blade made of a combination of synthetic and other material shall be provided on the scraper. The rake tines shall then be retracted and the unit ready for the next cycle. Drive chains, chain guides, chain sprockets, bearings, and axles shall be fully replaceable without having to remove the screen from the channel.

8.10.4 Rake Lifting Mechanism

Lifting Mechanism Chains shall be roller type chains and made of SS 316L and SS 316 sprocket of high tensile strength and resistance to corrosion. The maximum force each chain can take-up ~~is~~ shall be 112,000 Newton. Chain Pins shall be ~~a~~ of Stainless Steel construction and hardened.

Chain guide shall be securely fixed to the Screen frame for the full height of travel and shall not protrude into the flow. The type of chain guide, thickness of material and size is an L-Profile, Material Grade 316 Stainless Steel. Upper Bearings shall be of UCF Type or equal; housed bearings are grease-lubricated, mounted the Take-Up Frame assembly. No Bearings shall be submerged in the waste stream.

8.10.5 Inspection Platforms

An inspection platform shall be provided for periodic checking and maintenance of the drive and other critical parts. A ladder with handrails for access to this platform shall be fixed. Suitable hand rails shall be provided for safety on the inspection platform and also at deck level. The platform shall have holes to prevent from rain water accumulation.

8.10.6 Dead plate

SS316L dead plate extending from the top of the bars to the deck level shall be provided to ensure that screenings do not fall back. Dead plate shall be made of minimum 4 mm thick plate. The clearance between the tines and the dead plate shall not exceed 4 mm.

8.10.7 Discharge Chute

A discharge chute shall be of minimum 3mm thick provided for each screen to divert screenings discharged from the screen to a conveyor mechanism. The discharge chute shall be made of SS 316. The discharge chute shall be mounted at an angle of minimum 30 degrees. Panels are positioned on both sides to protect from splashing. Screenings are delivered down an enclosed chute. Two nos. Screening collection containers (wheeled) of suitable capacity shall be supplied with the screens.

8.10.8 Covers

Covers which are easily removable shall be provided for easy maintenance. Covers shall be constructed of clear impact-resistant Polycarbonate material thickness 6mm and SS 316 thickness is 2mm to allow for visual observation during screen operation.

8.10.9 Driving Mechanism

The driving mechanism shall consist of a sturdy reduction gear unit driven directly by an electric motor. A manually reset torque limiter shall be provided between the motor and gear unit, incorporating a limit switch to cut off the supply to motors in the event of an overload. The drive mechanism for the rakes shall incorporate a solid shaft constructed of SS 316.The drive to the main shaft shall be TEFC weatherproof IP55 motor fitted with an anti-condensation heater. The motor shall be flanged to a shaft mounted gear unit giving the final output speed. This shall produce a linear speed for the screen panels of about 3 m/min. The drive shall be protected from mechanical overload by an electrical current sensing device in the screen control panel. Overload prevention switches shall be provided to annunciate screen jamming. Suitable conveyer arrangement shall be provided to transfer the screenings to the nearest container/trailer. A spray system shall be provided to backwash the screen panels and to help in cleaning the screenings. Water / treated sewage shall be used for back wash purpose.

8.10.10 Installation

The screen shall be designed for installation to either (a) pivot out of the channel, (b) be pulled out of the channel. Non-metallic side flaps seal the screen to the channel walls, or (c) The Screen shall be grouted in a wall recess and/or floor recess.

8.10.11 Gear Reducer

(a) The reducer shall be sized and selected with a minimum service factor of 2.0 times the motor nameplate horse power rating in accordance with applicable American Gear Manufacturer's Association Standards. The reducer shall have a life of 40,000 hours based on the motor name plate horse-power. The reducer shall have an efficiency of not less than 90% based on reducer input.

(b) All gear meshes shall be oil lubricated. All gears shall be provided with an oil reservoir for instant lubrication on starting. The gear reducer housing shall be provided with an oil level indicator and oil drain with necessary fittings.

(c) The gear reducer shall be of cast iron construction. The reducer housing shall also include suitable lifting lugs and external gear train inspection covers for each gear train. The gears shall be matched for maximum tolerance variation. The gear reducer shall be suitable to reduce the motor asynchronous speed to achieve the required speed of raking.

8.10.12 Control System

(a) The screening operation shall be carried out through adjustable timers which are adjustable at site for 0-60 minutes for interval between two operations.

(b) Control system for the conveyor shall be designed to achieve the following:

(i) Conveyor shall be started when any of the rakes starts it’s upwards travel.

(ii) Conveyor shall be stopped with a time delay (by adjustable timer) after rake is stopped.

(c) Weatherproof, lockable, emergency mushroom headed stop push buttons shall be provided near each motor for screen and screw conveyor, operation of stop push button and overload prevention for screen and screw conveyor shall be included in the control scheme.

8.10.13 Screw Conveyor with compactor

(a) Technical specifications of Screening Conveyor

The Screening Conveyor shall be Shaft less Screw Conveyor and applied for conveying the floating debris to the next facilities. The screening system shall be supplied with a shaft less screw conveyor that will be used to convey the screenings to the automatic screenings press and discharge system that compacts, dewaters and discharges the screenings through a chute to the screenings storage system.

Dumping of the screenings on to the duty/standby conveyor opening shall be with the automatic deflection plate, which shall be positioned towards the conveyor which is selected from the

LCP/SCADA for the duty and automatically towards the standby if duty conveyor trips. Position of this deflection plate shall be interfaced with PLC.

Screening wash compactor shall be suitable for washing and compacting the floating waste coming out of the duty and standby shaft less screw conveyor in case of multiple screens, or directly from the screen in case of single screen installed in municipal waste water pumping station or treatment plant.

Shaftless screw conveyor shall be made of stainless steel of grade SS 304 and shall incorporate shaft less spirals. Cover plates for shaftless screw conveyors shall be provided along the entire conveyor length to contain splatter. Conveyor trough covers shall be made from 5 mm of specified grade of stainless steel single piece formed sheet metal, not greater than 1000 mm in length, attached to the screw conveyor trough using toggle clamps. The cover shall also be of sufficiently tight fit to prevent the conveyed media from leaking out of the conveyors. A minimum 2.5 mm neoprene gasket of 50 durometer shall be applied with an appropriate adhesive to the mating surfaces of the trough covers.

Its structure shall have excellent durability to continuous running for long time. It shall be well taken into account of abrasion resistance, corrosion and vibration resistance. It should have a structure which is free from debris material clogging.

The spiral flighting for the shaft less screw conveyors shall be designed to convey material without a center shaft. The spiral flights shall be designed with stability to prevent distortion and jumping in the trough while operating at design speed and design capacity. The spiral flighting shall be Stainless steel of grade SS 316.

Shaftless conveyor trough liner material shall be an ultra-high molecular (UHMW) polyethylene with a minimum 12 mm thickness. There shall be two colored layers in the liner material to indicate wear. The liner shall extend the full length of the trough, covering the entire semicircular bottom portion of the trough. The liner shall be secured at intervals not to exceed 1000 mm, using specified stainless steel retaining clips of an approved design.

Screening wash compactor shall be made of stainless steel of grade SS 316. The wash compactor will receive the waste through inlet hopper and the waste shall get dropped in to the conveying zone of the compactor main body.

Screw and liner shall have rigid thickness for resisting corrosion and abrasion caused during carrying of debris. Its structure shall be designed not to invite biting and clogging. Casing shall be equipped with inspection port to the necessity as well as for cleaning convenience. Driving device shall have overload limiting switch for avoiding broken situation caused by overloading.

The conveying zone shall have perforations at the bottom so that the water coming along with the wet screening is dropped in to the dewatering trough. The dewatering trough will have a set of nozzles positioned upwards so that the screening particles chocking the perforations will be removed by the force of spray water. The construction of the dewatering trough shall be inclined towards the drive end so as to enable the flow of water to the drain hole provided with an elbow connection. The compactor main body shall also have a drain hole with an elbow connection.

In the conveying zone there shall not be any impeller wheel or any other mechanical breaking device. The breaking up of organic matter shall be done solely by water through an assembly of nozzles connected with solenoid valves in a special washing zone between the conveying and the compaction zone. The screening shall move towards the compaction zone by a shafted screw of a constant pitch connected to a drive shaft. This drive shaft shall be connected to the drive unit through axial and radial bearings. An electronic device shall operate the drive unit of the spiral in a forward reverse mode, separated by a stand still period. The time of forward and reverse operation as well as the stand still time shall be freely adjustable.

The non-drive end of the screw shall have the flight of reduced pitch in the compaction zone. For achieving better strength at non-drive end, the screw must be supported by wear bars connected to the wash press main body and reinforced with double flights of defined pitch.

An elephant trunk shape outlet tube shall be connected to the compactor body with a flanged connection. An elbow shall be provided at the flanged connection to carry the washed screening in the reduction tube. The reduction tube shall be divergent to ease the push of the washed screening upward in to the outlet tube. The end of the reduction tube shall have an elbow with discharge plate/chute to enable the collection of the screenings in bagging units or a container.

The Screening wash compactor shall remove the organic material by washing and compaction thus reducing the volume and weight by 50%.

The main body of Screening wash compactor shall have a material thickness of minimum 3 mm and the bottom of the compactor main body shall be perforated with 5 mm holes.

The screw flights of wash compactor shall have a minimum thickness of 10 mm and at the end of compaction zone, there shall be wear bars of 10 mm thickness bolted to the wash press main body/tube for easy replacement.

The elephant trunk shaped outlet tube shall be diverging to prevent the waste getting clogged. The connection of the outlet tube to the main body shall be flanged type. All the bend fittings (elbows) in the outlet tube shall be long radius design.

Frequency Inverter shall be provided for Forward-reverse-forward motion of the screw and as overload protection device.

The gearbox of screw conveyor and wash compactor shall be hollow shaft, parallel helical gear unit have a minimum service factor of 1.2, oil bath lubricated with oil sealing. The motor shall be of TEFC type with minimum IP 55 protection & Class F insulation and be suitable for operation on 3 phase, 415V and frequency of 50 Hz. The drive shaft must be precisely machined and shall have radial and axial bearings.

The common control panel shall have IP 55 protection, painted with epoxy paint and shall be comprising of

- Mushroom head emergency stop.
- Overload relays for motor protection.
- Circuitry to operate the Screening conveyor and wash compactor with signal for start command from screen motor start and delay-timer based stop command after the screen motor stops.

- Selector switch to operate the Screening conveyor and wash compactor in Auto, manual and remote mode.
- Provision for suitable PLC circuitry shall be provided in case requirement of connectivity with SCADA system.

The Screw conveyor and wash compactor shall be supplied factory assembled and duly tested at manufacturer's works before dispatch. Upon receipt at site these shall be installed resting on the channel floor and mechanically or chemically anchored on to the platform in a way that there are minimum chances of misalignment.

Material of Construction

Screw	SS 316
Screw trough	SS 304
Screw cover	SS 304
Liner	Ultra-High Molecular Polyethylene (UHMPE)

Accessories

Anchor bolts and nuts	1 set
Special tools	1 set
Flexible joint for inlet and outlet	1 set
Liner (for spare)	1 set

8.10.14 Portable Screenings Container

Portable screenings containers made of galvanized steel shall be provided to store the screenings until time of pick up. Minimum two Screenings Containers shall be provided at the screening chamber. The container shall have capacity of approximate 2.0 cu.m and shall be of a convenient height to permit the discharge of screenings directly into the container without having to transfer the screenings manually. The containers shall have hinged covers and their design shall permit their being lifted by an overhead hoist or packer truck. The container will have four wheels each of minimum 40 cm diameter, Tyre type. The maximum height of container including wheels shall be 66 cms. The sides shall be constructed of 12 gauge steel. The bottom of container shall be made of 5 mm plate steel. The containers shall be reinforced with 50 mm x 50 mm x 5 mm angle.

8.10.15 Automatic Jam removal system

The screen shall have automatic electronically controlled Jam removal facility to ensure smooth operation without damaging the main equipment.

8.10.16 Motors

Motors shall be squirrel cage type conforming to IS 325. The Drive Motor shall be controlled by a Full Voltage Reversing Motor Contactor mounted on a Back Panel to be mounted in an Enclosure or MCC (Motor Control Center) in the main Panel. The power rating of motor shall be at least 125% of maximum power requirement. The other features of motors shall be as follows:

(i) Type of duty : Intermittent (S4)/ Continuous (S1) based on manufacturer's design

(ii) Method of Starting : DOL

(iii) Class of insulation : F (Temperature rise limited to class B)
(iv) Type of enclosure : TEFC
(v) Degree of protection : IP 55
(a) The material of construction of Mechanical Raked Screen shall be as follows :

S. No.	Component	Material
(i)	Screen	Stainless steel SS316L
(ii)	Frame (Side and Bottom Portion)	Stainless steel SS316
(iii)	Raked tines	Stainless Steel SS316L
(iv)	Fasteners including Anchor bolts	Stainless Steel : 316L
(v)	Screen canopy	Stainless Steel: SS316L
(vi)	Chutes	SS316

8.11 Manually Operated Travelling Crane

8.11.1 Crane

(a) The crane shall be manually operated.

(b) The capacity of crane shall be as per the equipment list in particular mechanical requirement and of class II.

(c) The crane bridge shall consist of a single bridge girder carrying two wheels at each end of the span. Steel used shall be tested quality steel conforming to IS 2062.

(d) The long travel bridge wheels shall be rim toughened; heat treated galvanized carbon steel or low alloy steel or C.I. They shall be double flanged type. The wheels shall have antifriction ball/roller bearings. The wheels shall be machined on their treads to match the runway rail section. The bridge shall have a geared shaft and pulley connecting to opposite wheels of the span, to achieve the long travel motion of the bridge, by means of a chain. The runway rails of adequate strength and rigidity, rail clamps and other accessories for mounting the rails and suitable end stops for the bridge shall be supplied by the Contractor.

8.11.2 Trolley and Chain Pulley Block

(a) The chain pulley block shall be operated on the lower flange of the bridge girder.

(b) The load chain shall be made of alloy steel as per IS:3109. It shall be heat treated to give ductility and toughness so that it will stretch before breaking. It shall be of welded construction with a factor of safety not less than 5.

(c) The hand chains, SS 316, for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The hand chain wheel shall be made from pressed sheet steel and shall be provided with roller type guarding to prevent snagging and fouling of the chain.

(d) All the gearing shall be totally encased. Proper lubricating arrangements shall be provided for bearings and pinions. Gears shall be cut from forged steel blanks. Pinions shall be of heat treated alloy steel. Gears shall be as per BS 436/IS:4460.

(e) The trolley track wheels shall be rim toughened, heat treated carbon steel or alloy steel and shall be single flanged and shall have antifriction ball bearings. The wheels shall be machined on their treads to match the flanges of the track joints.

(f) The travelling trolley frame shall be made of rolled steel conforming to IS:2062. The side plates of trolley frame shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalizing pin.

(g) Axles and shafts shall be made of carbon steel and shall be accurately machined and properly supported.

(h) The lifting hooks shall be forged, heat treated alloy or carbon steel of rugged construction. They shall be of single hook type provided with a standard depress type safety latch. They shall swivel and operate on antifriction bearings with hardened races. Locks to prevent hooks from swiveling shall be provided. Hook shall be as per BS:2903/IS:3815

(i) The brake for the lifting gear shall be automatic and always in action. It shall be of screw and friction disc type self-actuating load pressure brake. Brakes shall offer no resistance during hoisting.

8.11.3 Electrically Operated Hoists

(a) Electric hoists shall be complete with hoisting motor, wire rope drum, wire rope, hook, necessary gearing, sheaves, electromagnetic brake for hoisting motion, weather & dust-proof push button station, contractor panel, all wiring, limit switches, etc.

(b) Electric hoists shall conform to IS: 3938 and shall be suitable for outdoor application. All the parts of the hoist shall be designed to withstand surrounding atmospheric conditions without any deterioration.

(c) Rope drums shall be either cast or welded to sustain concentrated loads resulting from rope pull. Drums shall be machine grooved right and left with grooves of a proper shape for the rope used.

(d) Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one piece gear section. Hoist ropes shall be extra flexible, improved plough steel rope with a well lubricated hemp core and having six strands of 36 wires per strand with minimum ultimate tensile strength of 1.6 x 106 KN / Sq.m.

(e) Hooks shall be solid, forged, heat treated alloy or carbon steel of rugged construction of the single hook type and provided with a standard depress type safety latch.

(f) Hoisting motor shall be equipped with electrically released, spring set, friction shoe type brakes having torque capable of holding 125% of the full rated hook load. Brake shall apply when either the motor controller or the main power switch is in 'OFF' position or in the event of power failure/

(g) Drive motors shall be designed for frequent reversal, braking and acceleration and shall be as per IS:325. Pendant control switch, controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS:3938. Limit switches shall be provided for over-hoisting and over-lowering.

(h) The electric hoists shall be of Class II duty.

(i) 25% overload test, speed tests, limit switch tests and brake test shall be conducted for the hoist and trolley at manufacturer's works.

(j) Minimum Two sets of sufficient slings, ropes, shackles, lifting beams, etc shall be supplied to handle all items of plant covered by the crane. They shall be labelled or marked with the Safe Working Load (SWL) and the purpose for which they are intended.

8.11.4 Hand Operated Hoists and Trolleys

(a) Manual hoists shall be complete with hand-chain, trolley, pulley block, hook, hand and load chains, brake and other accessories. They shall comply with the latest applicable standards, regulations and safety codes in the locality where equipment will be installed.

(b) Each hoist shall be operated on a monorail (I-Beam). The factor of safety shall not be less than 5. The load chain may be heat-treated to give ductility, toughness and conforming to I.S. 3109/B.S.1663/B.S.3114. The load wheel is to be made from heavy duty malleable castings. The hand chain is to Conform with B.S. 6405:1984 and hand chain wheel may be made from pressed sheet steel with roller type guarding. Gears shall be cut from solid cast or forged steel blanks or shall be stress – relieved welded steel construction.

(c) Pinions shall be of forged carbon or heat treated alloy steel. Strength, Quality of Steel, heat treatment, face, pitch of teeth and design shall confirm to BS-436, BS-545 and BS-721. Spur and helical gears must comply with B.S. 436 and worm with BS 721. Bearing must be ball and roller type conforming to I.S. 2513/B.S., 2525-32:1954.

(d) Proper lubricating arrangements are to be provided for bearings and pinions. The brake for the lifting gear shall be automatic and always in action.

(e) The proof testing of each chain pulley block is to be carried out as per latest applicable standards. The safe working load is to be marked in such way that is clearly visible from the operating level.

8.11.5 Electrically Operated Overhead Travelling Crane

(a) The crane shall be electrically operated, bridge type complete with all accessories including down shop conductor, crane rails and fixtures, and shall conform to BS 2573, IS:3177 or equivalent internationally approved standards.

(b) The crane bridge shall consist of bridge girders on which a wheeled trolley is to run. The bridge trucks and trolley frames shall be fabricated from structural steel. Access walkway with safe hand

railing as is required along the full span length of the bridge girder. Steel shall be tested quality conforming to ASTM A36 except that, plates more than 20 mm thick shall conform to IS:2062, BS:4360 or relevant internationally approved standards.

(c) The bridge shall be designed to carry safely the loads specified in IS:807, BS: 2573 or relevant internationally approved standards. All anti-friction bearings for bridge and trolley track wheels, gear boxes and bottom sheaves on hook shall be lubricated manually by hand operated grease pump through respective grease nipples.

(d) Wheel base and structural frame of the wheel mounting of the end carriages shall be designed so as to ensure that the crane remains square and prevent skewness. Bridge and trolley track wheels shall be of forged steel and shall be double flanged type. The wheel diameter and rail sizes shall be suitable for the wheel loads.

(e) The crane rails shall be manufactured from wear resistant austenitic manganese steel. If not available, Alternately can propose for MS square bright bars after approval of Client/Consultant. Mountings of the wheels shall be designed to facilitate easy removal for maintenance. Walkways shall be at least 500 mm clear inside width with a 6 mm thick non-skid steel plate surface. Steel rail stops to prevent rails from creeping and trolley from running off the bridge shall be abutted against ends of rails and welded to the girders. Bridge and trolley stops to match the wheel radius shall be provided before the buffer stops.

(f) All exposed couplings, shafts, gear, wheels, pinions and chain drives etc. shall be safely encased and guarded completely to prevent any hazard to persons working around. All bearings and gears shall have a design life of 100000 hours. Electro-magnetic and hydraulic thrust or brake shall be provided for the main hoist. One electro-magnetic brake shall be provided for each of the cross travel and long travel motions.

(g) Hook shall be solid forged, heat treated alloy or carbon steel suitable for the duty service. They shall have swivels and operate on ball thrust bearings with hardened races. The lifting hooks shall comply with the requirements of IS 8610 or BS: 2903 / BS: 3017 or relevant internationally approved standards and shall have a safety latch to prevent rope coming off the hook.

(h) Hoist rope shall be extra flexible, improved plough galvanized steel rope with well lubricated hemp core and having six strands of 36 wires per stand with minimum ultimate tensile strength of 1.6 X 106 kN/m2 of Right Hand Ordinary (RHO) lay construction. The ropes shall have a 6:1 safety factor on the specified safe working load, and shall conform to IS:2266. Rope drums shall be grooved and shall be either cast iron or cast steel of or welded steel conforming to IS:3177, BS:466 or relevant internationally approved standards.

(i) Gears shall be cut from solid cast or forged steel blanks or shall be stress relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, quality of steel, heat treatment, face, pitch of teeth and design shall conform to BS:436, IS:4460 and BS: 721 or relevant internationally approved standards.

(j) Name Plate showing the capacity, year of manufacture and rated capacity of hoist in figures not less than 150 mm height shall be placed on each side of the crane girder.

(k) The maximum deflection under full load shall not exceed 1/900 of the span (as per IS: 3177).

(l) All accessory and auxiliary electrical equipment including drive motors, electrically operated brakes, controllers, resistors, conductors, insulators, current collectors, pendant push button station, protective devices, operating devices, cables, conduits, etc. necessary for the safe and satisfactory operation of the crane shall be provided. (Power to the crane shall be provided by down shop conductors manufactured from high conductivity hard drawn copper. Conductors shall be completely shrouded such that they have no exposed current carrying surfaces.

Pendant type push button station shall be sheet steel enclosed and shall comprise the following push buttons and indicating lamps:

a. `Start' and `Stop'.
b. Long travel - `Right' and `Left'.
c. Cross travel - `To' and `Fro'.
d. Hook - `Hoist' and `Lower'.
e. Red indicating lamp for supply `ON' indication.

(m) Pendant type push button shall be supported independently of the electrical cable and shall be earthed separately, independent of the suspension. Automatic reset type of limit switches shall be provided to prevent over travel for each of the following:

a. For `UP' and `Down' motions of the hook.
b. Long travel motion
c. Cross travel motion

(n) Crane structures, motor frames and metal cases of all electrical equipment including metal conduit and cable guards shall be earthed. All motors, brakes, limit switches, panels, drum controllers, resistor unit sets shall be provided with two studs for earthing.

(o) The crane, and all slings, ropes, shackles and other lifting equipment supplied shall be tested by the manufacturer at his works. The tests shall be carried out at 125% of Safe Working Load, and Test Certificates shall be supplied.

(p) All motors shall be of the quick reversing type with electric mechanical brakes suitable for the duties specified. All movements shall be electrically powered suitable for operating with the hook loaded. Facilities shall be provided for the accurate location of the hook by means of `inching' the cross travel and down shop travel motions.

(q) Sufficient slings, ropes, shackles, lifting beams, etc shall be supplied to handle all items of plant covered by the crane. They shall be labelled or marked with the Safe Working Load (SWL) and the purpose for which they are intended.

(r) The Contractor shall include with the cranes all necessary contactors, control cubicles and protection equipment necessary to operate the crane and provide adequate electrical protection against overload, phase and earth fault and fail-safe protection in the event of an interruption in the power

supplies. All access ladders and platforms necessary to carry out maintenance and repairs shall be provided and installed by the Contractor.

(s) All electrical equipment shall be fully tropicalised.

(t) Site tests shall be carried out by the Contractor who shall supply the necessary materials for the test load. The test load shall be removed from site by the Contractor after successful tests have been carried out.

8.11.6 Jib cranes

(a) Fixed Jib Cranes shall be provided for each clarifier in the lowering/removal of equipments/parts to/from the clarifier floor and transferring the same outside the clarifier area. The Jib Crane capacity shall be 1.25 times the maximum weight to be handled in the clarifier or 1.5 Tonnes whichever is maximum.

(b) The lift and reach of the cranes shall be suitable for the clarifier offered. The crane shall be capable of being swivelled by 360°. Adjacent halves of clarifiers may be provided with common jib crane if feasible.

All materials used in the construction shall be corrosion resistant. Mild steel used shall be galvanised. Ropes, chains and pulleys shall be of stainless steel construction. Hardware shall be of SS 316. Two number of Jib crane shall also be provided for handling submersible mixers in Pre-Anoxic and Anaerobic Tank area to lower the submersible mixers from platform level to ground level.

8.12 Grit Removing Equipment

8.12.1 Vortex Grit Mechanism with Air lift Pump

Grit removal equipment shall comprise vortex grit separators, sized to achieve the specified operating criteria and each shall operate in conjunction with a grit classifier. The Contractor shall make his own assessment of the amount of grit which will be produced by this equipment and the design of the grit handling systems shall be sized accordingly. However, grit removal and washing system shall be designed for maximum grit load of 12 kg/Million litre of sewage. Grit separators shall be complete with all necessary ancillary equipment and controls. The plant shall be controlled by PLC suitable for SCADA. An interlock shall be provided between the grit removal device and the grit classifier.

Vortex Grit Trap

- The circular tank grit trap shall be supplied complete with geared motor, gear head assembly, impeller drive tube, impeller, air lift pump and air wash/airlift assemblies.

- The grit separator shall be designed to efficiently remove grit from waste water inflows to protect downstream components of the Treatment Plant. They shall utilize the special characteristics of controlled hydro dynamic flow, to separate settleable solids and operate at high hydraulic loadings to minimize facility space requirements.

- A tangential inlet shall induce a vortex flow pattern within the separator hence creating ideal conditions for the potential currents of a vortex funnel. The resulting flow patterns shall be well defined and low in turbulence leading to favorable conditions for grit settling.

- The grit removal chamber shall have inlet and outlet separated by 270 or 360 degrees of the tank periphery. There shall be a sloping floor connecting the upper and lower sections.

- The flow shall enter through the tangential inlet channel; spiral and rise through the separator, flows through the annular opening created by the conical section and the overflow floor, over the overflow weir and out through the de-gritted overflow channel.

- Grit and other settleable solids shall drop to the sloped bottom and be concentrated into the unit sump. The concentrated grit shall be removed from the sump using a grit pump or airlift pump.

- A conical section extending into the interior of the vessel shall be used to stabilize the secondary currents and increased the boundary surfaces to induce further grit settling.

- The collected and concentrated grit in the sump shall be pumped to a screw classifier which shall be used to wash and classify the grit in order to minimize organic solids concentrations in the grit discharge. Organic matter in washed grit shall not exceed 3% (w/w).

- The grit trap shall be designed such that the head loss is less than 10mm. The design shall be capable of removing grit from screened sewage and depositing grit into the grit classifier.

- The grit removal device shall be fitted with a rotating impeller. The impeller shall be manufactured in two halves and shall be clamped to the drive tube when fully assembled. The stub shaft should not have any supporting bearings under the water and should be hanging from the gear head assembly.

- The impeller shall be fitted with four fixed blades set at an angle of 30 degrees and provide sufficient washing action to prevent lighter solids entering the classification gap between impeller and grit hopper whilst allowing settled grits through for collection.

- The impeller blades shall create a slight upward flow in the central zone of the upper chamber whilst leaving the outer annulus of the upper chamber quiescent to allow grit settlement.

- The impeller shall be driven by a helical geared motor with a service factor of 2.0 or greater.

- The geared motor shall be fully weather proofed and shall be oil lubricated and the drive shall incorporate a slewing ring bearing and helical spur gearing transmission. Torque limiter to be provided for protecting the drive unit.

- An air wash/airlift assembly shall be provided to facilitate grit washing and removal. The assembly shall consist of an airlift pump discharge pipe, minimum 150mm diameter, with air wash and airlift headers. Separate air supply lines consisting of minimum 80mm diameter pipe shall connect to the air wash and airlift header. The air wash header shall discharge an adequate quantity of air for air

washing of the collected grit. Each air delivery line shall terminate above the drive gear head and connected to a three way ball valve, minimum 80mm diameter, with automatic operation.

- The Contractor shall supply blower and pipework to provide air for the air wash/airlift operation. The blower shall have the capacity to provide sufficient quantities of air at the required pressure to ensure efficient operation of the air wash/airlift system.

- All internal parts and weirs shall be stainless steel Grade SS316

Screw Grit Classifier

- Each grit separator shall have an individual grit classifier.
- Delivery pipework from the pumps in separate rising mains must be provided and connected to the storage reservoir, complete with support brackets from the vortex degritter to the grit classifier equipment.
- The grit classifiers shall be capable of handling the Waste water and grit removed from the grit separators at the rate discharged by the grit air lift pump or pumps.
- The grit classifiers shall be free standing units of the helical screw type which shall efficiently deposit dry organic free grit to a skip positioned beneath the discharge chute.
- A wash down water supply shall be connected into the classifier to assist with washing the grit.
- The units shall be provided with a valved washout drain at the lowest point which shall be piped, together with the wash water overflow, to a local drain point.
- The screw drive motor unit shall be mounted at the upper end of the screw trough. The whole of the unit shall be guarded over its whole length.
- The screw conveyor shall use a shaft-less screw resting on wearing surfaces. The screw device shall not have a submerged end bearing.
- The screw shall be formed in stainless steel Grade SS316 plate of 8mm minimum thickness and the trough of the same metal in 6mm plate.
- The wearing surfaces in the screw trough shall be easily replaceable and formed of high density polyethylene (HDPE).
- The screw shall be fitted on one bearing placed in the drive unit. The bearing shall be a combined thrust and radial type sufficient to accommodate the total axial and thrust loading.
- The screw conveyor shall have adequate accessibility for maintenance.

Operating Conditions

The grit chamber shall operate on the vortex principle. To maximize grit removal efficiency, the grit chamber hydraulics shall incorporate a toroidal flow path enhanced by a slow vortex. The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate.

- 90-95% of the grit greater than 150 microns in size,
- 75-85% of the grit greater than 100 but less than 150 microns in size,

The displacement type blower shall have the capacity to provide sufficient quantities of air at the required pressure to ensure efficient operation of the air wash/airlift system.

MATERIAL OF CONSTRUCTION	
Grit Chamber	Concrete M30
Wetted Parts	SS316L
Classifier	SS316L
Classifier Screw	SS 316
Water Contact Parts of Concentrator	SS316

8.12.2 Vortex Grit Mechanism with Slurry (Turbo) Pump

GENERAL

The Grit Chamber shall operate on the vortex principle. Each Vortex Grit Chamber, complete with all accessories including, but not necessarily limited to: gear motor, gear head, air bell, propeller, drive tube, axial flow propeller, Grit Removal Turbo Pump and auxiliary equipment as specified herein shall be provided.

The grit removal device shall be capable of removing the following at the specified hydraulic peak flow rate, and no decrease in efficiency will be allowed at flows less than this design rate.

- 95% of the grit greater than 150 microns in size.
- 85% of the grit greater than 100 microns.

Organic removal: The final dewatered grit from the classifier / washer shall contain less than 5% putrescible organic matter on dry basis.

System Description:

- The Grit Chamber shall operate on the vortex principle. Each Vortex Grit Chamber, complete with all accessories including, but not necessarily limited to: gear motor, gear head, air bell, propeller, drive tube, axial flow propeller, Grit Removal Turbo Pump and auxiliary equipment as specified herein shall be provided.
- The Vortex Grit removal system shall be installed in concrete basins.
- The grit removal chamber shall have inlet and outlet separated by 270 or 360 degrees of the tank periphery.
- The Grit Chamber shall handle all flows equal to or less than a hydraulic peak flow. The influent flume, transporting the liquid waste to the Grit Chambers should assure that grit does not settle in the inlet flume for proper operation of the Grit Chamber.
- The Grit Removal Unit shall have lesser head loss and shall be capable of removing grit from raw waste or process water and depositing the grit in a storage hopper.
- No moving parts subject to wear or stoppage shall be below the water surface.
- An influent baffle or equivalent and inlet coanda ramp shall be provided to enhance the coanda effect and direct the grit downward to the bottom of the separation chamber as well as enhance chamber flow patterns.
- To minimize the possibility of organic capture, the floor of the grit separation chamber shall be flat and opening for grit to pass through to the storage hopper.
- To ensure the efficient transport of the grit and simultaneous lifting and discharge of the organic material, the bottom of the upper chamber covering the storage hopper shall be constructed of structural grade SS316 plate, free from rotation, and shall be flat.

- The grit moving across the bottom of the chamber shall be hydraulically scoured as the propeller blades, moving within 150 mm dia. of the grit, pass over the moving grit and cause hydraulic currents to lift up the organics. The propeller blades shall have a rounded leading edge be designed to provide pumping action inside the chamber.
- To maximize grit removal efficiency, the grit chamber hydraulics shall incorporate a toroidal flow path enhanced by a slow vortex. Grit chambers incorporating the gravity principle will not be acceptable due to the turbulence in the flow, which prevents gravity settling from being effective and due to the extra area needed for settling fine grit.
- Sloping floors in the upper chamber will not be allowed due to reduced grit removal efficiency and higher organic capture.
- The grit shall pass from the removal chamber through an opening in the transition plate and drop into a grit storage hopper.
- Grit pump shall be remote mounted / top mounted turbo grit pump with curved multi vane impeller.
- An integral grit pump shall be provided to transport the grit from the storage hopper to the grit classifier / washer and the dewatered grit shall be temporally stored in tiltable trolley.
- To minimize the possibility of clogging, all internal openings in the piping to the grit pumping device as well as the grit pumping device shall be large enough to pass 80 mm solid size.
- No bends or elbows will be allowed in the piping on the suction side of Grit Pump.
- The Grit Concentrator shall operate on the constant rate vortex principle. Design shall be such that a small volume of water and the grit will discharge at the bottom for final dewatering and ultimate disposal of the grit.
- Grit Screw Classifier / washer shall be with an inlet hopper to receive the mixture of water and grit each from the Grit Concentrators.
- All drives, lubrication and bearings shall be readily accessible from walkways above the operating water level.

Material of Construction:

- All wetted parts shall be in SS316.
- The pump shall be of Ni-Hard construction, with Ni-Hard impeller, and especially designed for the use of mechanical seals. The shaft shall be solid stainless steel through the mechanical seal, heavy duty bearings and mechanical seal.
- Grit concentrator shall be constructed of Ni-Hard with a minimum thickness high wear areas, it features a large discharge orifice to minimize clogging.
- Grit Screw Classifier / washer shall be constructed of SS316.

8.13 Primary and Secondary Sedimentation Tanks

Circular (radial), fixed full bridge with scum collector, Central turns drive type, collecting effectively with proper circumferential speed, clarifiers shall be provided. The clarifier shall be rugged and robust in design and shall be provided with high capacity drive head and induction motor having high torque rating, centrally located, with positive sludge raking by means of one or more raking arms. Both the raking arms should have scraper blades fitted at the bottom, so that the sludge from scraper blades is pushed to the sump on every rotation.

(a) The drive head mechanism arrangements shall consist of a center turn table base casing mounted on top of the center pier and shall have an angular ball bearing mounted internal gear that

supports the underwater mechanism. The pinion meshing with the internal gear should be driven through a worm gear reduction unit mounted on top of the turn table drive unit. The balls should ride on hardened steel strips set into grooves in the base and gear casing so that they can be readily replaced whenever required.

(b) The unit will have mechanical overload arrangement with a torque indicating arrangement along with necessary contacts for tripping the motor in the event of overloading. This condition shall be annunciated. The unit shall have push button station near the motor and starter with push button shall be provided in the control room, i.e. the return activated sludge pump house along with necessary switches. The clarifier unit should also be provided with necessary M.S. scum trough, scum baffles, skimmer assembly, M.S. rake blades, arms and brass squeezes. The V-notch weirs shall be 4 mm thick of SS 304 with SS 316 clamps & fasteners etc. for making the necessary adjustments.

(c) The Full bridge connecting from one periphery to another periphery of the tank through center pier shall have walkway covered with chequered plates and provided with hand railing on both sides.

(d) The Clarifiers shall have a bridge complete with 1200 mm walkway for personnel access to the centre, access stairs to ground level and hand railing, a motor driven sludge scraper complete with all necessary controls, delivery pipe work, a stilling well and overflow steel weir plates. Hand railing, Aluminum Chequered plate walkways of minimum 6 mm thick, access steps etc. shall be galvanized. Handrails shall be of tubular construction and made of 50 NB pipes heavy duty class.

(e) Corrosion allowance of 2 mm shall be taken in the structural sections of scraper arm, bridge etc.

(f) Structural design calculations shall be submitted for all structures including scraper arm, bridge etc.

8.14 Fine Bubble Tubular Membrane Diffusers

(a) In this subsurface aeration system, air is introduced by diffusers submerged in waste water.

(b) The diffuser shall be fine bubble membrane tube type diffuser consisting of a single piece injection-molded polypropylene/uPVC tube surrounded by a membrane sleeve with maximum outer diameter (OD) shall not be more than 90 mm. The porous membrane material shall be of PU/Silicon based on the process requirement and durability for long run. Membrane retainer clamps with fasteners shall be of SS 316, clamping shall be done either side of the membrane.

(c) No drilled holes on the support tubes are permitted and only channel type arrangement for entry of air into membrane is desired. Air opening on the membrane should be 0.5 to 2.5 mm with staggered perforations.

(d) The design of membrane sleeve should prohibit clogging of the pores which are self closing when air flow/pressure is interrupted. The membrane should have anti adhesive surface which is resistive to grease, oil, hydrocarbons & precipitating chemicals and be resistant to microbial growth.

(e) The air distribution channel should extend over the entire effective length for an even distribution of air for bubble formation.

(f) These membranes shall be provided preferably with lower perforation sizes with suitable perforation pattern which when applied with a lower diffuser throughput rate and correct distribution of the diffusers on the bioreactor floor will result in a very high oxygen transfer efficiency (OTE).

(g) The rising velocity of bubble should be lower.

(h) The bubble should retain a solid spherical shape. The bubbles produced from the diffuser shall be minimum 0.5 mm. The flow fine bubble shall provide gentle mixing which prevents flock shear.

(i) Bubble should move in a helical fashion for lower bubble diameter so that it travels a longer path. The membrane tube diffuser shall have complete system i.e. air header, support pipes, locking bolts etc.

(j) The aeration system shall be removable without needing to drain or partially drain the tanks.

(k) The Standard Oxygen Transfer Rate (SOTR) operating ranges shall be achieved with all aeration zones operating at varying air supply rates.

(l) Contractors should provide their recommended minimum airflow rates for each zone in order for their diffusers to maintain the activated sludge mixed liquor suspended solids (MLSS) in suspension and avoid deposition of sludge in the Aeration Tank/Bioreactor. Provide fine bubble membrane type diffusers of a type that will prevent backflow. The Aeration system shall be suitable for prolonged isolation of the air supply, while preventing backflow seepage through the diffusers.

(m) Provide the membrane fixed to the membrane holder in a manner which does not introduce unbalanced stresses and increases sealing pressures as the air flow rate to the diffuser risers.

(n) Provide a back flow prevention device built integrally with the diffuser that prevents backflow into the diffuser and air piping.

(o) Provide an airflow control orifice to ensure even airflow distribution among all diffusers. Ensure that the airflow to any one diffuser is within plus or minus 5% of the average value, at all airflows.

(p) Provide a maximum diffuser flux rate such that the stress in the diffuser material is within elastic loading limits with a safety factor of at least 10. Submit test results, calculations, and any other documentation to exhibit that the membrane material will be able to withstand operating loads without undue stress or strain leading to failure in compression or shear, or creating significant mechanical creep of the material which would impair functioning or would cause enlargement of the membrane perforations or holes.

(q) Provide the tolerances of the diffusers and the diffuser mounting bases such that any diffuser and any gasket may be assembled onto any mounting base and provide a seal capable of withstanding the applied hydrostatic and/or pneumatic head.

(r) Provide diffusers mounted by the action of a threaded component that shall require measurement of the applied torque to the threaded component during tightening. The torque measurement shall lie within the range of torques specified by the diffuser equipment supplier.

(s) Provide diffuser material resistant to chemical attack, UV light, weathering and aging. Submit test results, certifying the integrity of the membrane. Provide data indicating the susceptibility of the membrane material to attack by various chemicals.

(t) Provide all rubber components manufactured from synthetic rubber materials proven to be resistant to corrosion, degeneration or abrasion in the environments proposed.

(u) Provide diffusers capable of withstanding a maximum differential pressure of 30 kPa and a maximum air temperature of 80˚C. Provide protective storage of rubber and plastic components of diffusers prior to installation.

(v) Provide effective cover to the diffusers after installation to protect them against physical damage and the ingress of dust and dirt before filling the new Tanks with water.

(w) The fixed diffuser Arrangement system should provide equal distribution in the aeration basin and there should be any dead zones in the basin. Diffusers should be installed in equidistance and shall be anchored & grouted with SS 316 fasteners and SS 316 clamping arrangement.

(x) Diffusers shall be equally distributed in the aeration basin and there should be any dead zones in the basin such that it should provide complete mixing and aeration of basin contents. Complete diffuser shall be assembled at original factory level but site fabrication of diffuser is not acceptable.

Diffuser Piping:

(a) Space diffusers evenly along each header.

(b) Furnish all components necessary to provide a complete mixing and aeration system. Work shall include but not necessarily be limited to the following:

- ✓ Flanged connections (SS 316) at the upstream side of each drop leg for connection to an isolation double flanged metal seated Butterfly Valve Gear operated.
- ✓ Stainless steel Drop legs (SS 316).
- ✓ Slip joint connections to the air distribution header (SS 316).
- ✓ Stainless steel Air distribution headers (SS 316).
- ✓ Diffuser connectors (SS 316).
- ✓ Tubular diffuser assemblies with silicone elastomer membranes with anti-microbial coating.
- ✓ Anchored Supports (SS 316) as necessary.
- ✓ Gaskets.
- ✓ Header joints (SS 316).
- ✓ Bolts, nuts and washers (SS 316).

(c) Provide two tubular diffusers at each header connection. Mount to a reinforced tee located on the bottom centerline of the header. The reinforced Tee shall be adjustable to allow accurate alignment of the diffuser.

(d) The Diffusers should be able to withstand high blower air and water temperature.

8.14.1 Diffuser Assembly

✓ Provide orifice flow control to ensure orifice head loss is at least 2.5 times the head loss in the air header at all air flow rates in the diffuser's design operating range.

8.14.2 Air Header and Droplegs

(a) Header and drop legs shall be constructed of 316 stainless steel.

1. Bottom elevation of the air distribution header shall be same throughout the tank.
2. Design connections between sections of the air distribution header to allow individual header sections to rotate independently of adjacent header sections.
3. Header dimensions shall conform to dimensional tolerances specified in ASTM A554-89 and ASTM A530-87.

(b) Furnish a drop leg from the air main connection at the top of the tank.

1. Provide a slip joint connection between the drop leg and distribution header.
2. Support the drop leg from the connection at the air header.

(c) Use factory welding only; field welding shall not be allowed.

1. Wire brush outside of each weld area.
2. Remove all discoloration and deposits left by welding by pickling.
3. Factory weld all diffuser connections. Stiffen both the diffuser connectors and the headers to withstand a moment of 56.5 N.m at the connector without permanent deformation.

(d) Passivate all SS 316 assemblies and parts after fabrication by immersion in a pickling solution of 6 percent nitric acid and 3 percent hydrofluoric acid at 60° C for a minimum of 15 minutes.

1. Neutralize by immersion in a tri-sodium phosphate rinse.
2. Submit certificate that this has been done.

8.14.3 Supports and Anchors

(a) Provide wall and floor mounting supports for all drop legs and air headers as necessary to anchor firmly on the wall and to the bottom of the tank and as specified herein.

(b) Anchor supports to concrete walls and floors using stainless steel expansion bolts sized and spaced as required for the loads encountered.

(c) Design supports to allow leveling the air header and diffuser assemblies to within specified tolerances.

(d) Provide expansion couplings in the drop legs and air headers as necessary to accommodate anticipated thermal expansion and contraction.

1. Submit expansion coupling design as well as computations for sizing.

8.14.4 Spare Parts

Provide spare parts in the quantities indicated.

Item	Quantity
Diffuser Assemblies	10%
Orifice Inserts	10%

8.14.5 Installation

(a) Install all components in accordance with the manufacturer's instructions and recommendations.

(b) Install all diffusers to within +/- 10 mm of a common horizontal plane.

8.14.6 Field testing

(a) All Fine bubble diffused aeration systems will be field tested.

(b) Testing will verify the installation as well as the diffuser's ability to deliver the specified air flow rates at the manufacturer's stated pressure loss. Testing will also verify the uniformity of mixing provided.

(c) Leveling tests:

3. Introduce clear water into each tank to the top of the diffuser elements.
4. Check the level of the diffusers to document that all element horizontal surfaces are within 10 mm of a common horizontal place and at the specified elevation.

8.14.7 Leakage and distribution of flow tests:

(a) After successful completion of the leveling tests, raise the water level to 50mm above the manifold.

(b) Visually inspect the water surface to ensure that the airflow is uniformly distributed across the tank.

(c) Pressure test:

All of air supply pipe line shall be tested by pressure. Test pressure shall be at least 2 times higher than normal operation pressure.

(d) If client is unsatisfied any test result, repeat the test until the installation is essentially void of air leaks.

(e) Repair any leaks in the elements holders, elements, pipes or the like.

8.14.8 Disc Fine Bubble Aeration System

Design:

The Disc membrane diffuser shall be developed specifically for Releases 1~3mm fine bubble in the wastewater treatment plant. All materials have been selected for their ability to withstand the effects of the chemical, bio-chemical agents and 0~100°C used in wastewater tank. The diffuser can be placed in an evenly distributed grid system over the entire aeration tank bottom. Air can be easily through the air orifice and integrated non-return valve into the wastewater. The air orifice design to maintain the diffuser standard airflow input prevented the max. air enter to damage diffuser membrane. The membrane shall be secured onto the support dish with a constrict flex rim and retaining ring designed to increase the tension on the point of engagement as the diffuser air rate increases.

Construction:
The materials of construction for both support dish and membrane diaphragm are non-corrosive and UV resistant. The support dish shall be upward facing convex plastic (Glass filled reinforced Polypropylene) for working without any acid dosing requirements and integrated non-return valve designed for back-flow prevention while airflow is interrupted. The membrane diaphragm which covers the dish is made of high grade EPDM resistant to the usual sewage ingredients. The membrane shall be further fastened to the support dish with a U-type retaining ring without special tools for fastening or replacement the membrane.
Aeration system shall be retrievable grid, membrane disc fine bubble aeration system
The fine bubble aeration system will comprise:
Stainless steel (SS316) droplegs and Headers.

- SS316 manifolds and air distributors.
- SS316 diffuser holders and retainer rings.
- Stainless steel supports and anchors
- Bolts, nuts and gaskets for aeration system flange connections.
- Air distributor purge systems.
- Membrane disc diffusers with integral O-ring gaskets and subplates.

The following design features will be incorporated in the fine bubble aeration system:

- Fabricated manifold with fixed threaded union joints for connection to the air distributors.
- Manifold sections connected with fixed threaded union or flanged joints to prevent rotation or blow apart.
- Manifold, distributor connections and supports designed to resist thrust generated by expansion/contraction of the air distributors over a temperature range of 70°C
- Air distributors perpendicular to the air manifold
- Fabricated distributors with single diffuser holders solvent welded to the crown of the air distributor for complete air seal and strength.
- Distributors and holders designed to resist a dead load of 90kg applied vertically to the outer edge of the diffuser holder.

- Air distributor sections joined with positive locking fixed threaded union or flange type joints for all submerged header joints to prevent blow apart and rotation. Bell and spigot, slip on or expansion type joints are not acceptable for submerged joints.
- Threaded union joints designed with spigot section connected to one end of the distribution header, a threaded socket section connected to the mating distribution header, an "O" ring gasket and a threaded screw on retainer ring. Solvent welding shall be done in the factory.
- Air distributor support spacing at a maximum of 2400 mm.
- All supports designed to allow for thermal expansion and contraction forces over a temperature range of 70°C and to minimize stress build up in the piping system
- Supports designed to be adjustable without removing the air distributor from the support.
- Diffuser assembly comprising: diffuser membrane with integral 'O' ring, sub-plate, holder, retaining ring and air flow control orifice.
- Integral check valve incorporated into the membrane diffuser assembly
- PVC support plate incorporated to form an air plenum under the diffuser and support for the membrane when the air is off
- Retainer ring threads designed with minimum cross section of 3mm and to allow for one complete turn to engage threads.
- A liquid purge system to drain the entire submerged aeration piping system for each aeration grid including airlift purge eductor line and manual control valve.
- Circular membrane diffuser discs with integral O-ring will be manufactured of EPDM synthetic rubber compound with precision die formed slits. Thermoplastic materials (i.e. plasticized PVC or polyurethane) are not acceptable.
- Carbon black will be added to the EPDM material for resistance to ultraviolet light.
- The maximum tensile stress on the diffuser will be limited to 10 psi (69 kPa) when operating at 2.4 SCFM/sq. ft. (43.9 Sm3 /h per m 2) of material. Proportionately thicker material is to be furnished for larger diameter disc diffusers to limit the maximum tensile stress and to resist stretching.
- Supports and anchors, spare parts, installation method, field testing, leakage and flow distribution tests shall be same as per above clause nos 8.18.3 to 8.18.7.

8.15 Blowers

8.15.1 High Speed Turbo Blower

The Air Blower Arrangement shall be capable of handling Total Water Level and Bottom Water Level operation conditions controlled by process sensors such as DO, Temperature and Level. Minimum turndown of 50% shall be achieved at lowest operating pressure as per process requirement.

All Air Blowers shall operate via VFD. Air Blower shall be Single Stage, Direct Drive, CE/UL certified, Centrifugal type Turbo Blower consisting of Air Bearings, Impeller, high-speed PMSM Motor, Inverter, Controller and Cooling System. Blower RPM shall be minimum 20,000. It shall be able to operate under varying pressure and flow conditions as per process requirement. The maximum idle time between OFF and ON shall not exceed 30 seconds.

It shall be composed of Casing, Suction Filter, Reducer, Acoustic Hood, Blow-Off Valve, Inverter, Electrical Panel and Controller etc. Noise level should be less than 85 dBA at 1.00 m from Blower whereas Vibration level should be less than 2 mm/sec.

Casing shall be of high-quality Aluminium Alloy and able to resist thermal expansion, vibration and air leakage.

Air Bearings shall be non-contact type, bump type foil air bearings with oil free lubrication, low noise and no vibration. The wearing surfaces shall be made of Inconel. Air Bearings should be able to withstand minimum of 50,000 On/Off in its life time.

The Air Foil Bearings should be Bi-rotational type. The same shall be witnessed during inspection of the Turbo Blowers without which the Turbo Blowers shall not be approved.

The bearing consists of top foil and bump foil. Top foil material is nickel alloy coated with Teflon and bump foil is nickel alloy. It is designed to maintain high load bearing capability to sustain the weight of the rotating assembly.

Impeller shall be of high strength Aluminium Alloy (AL7075). It shall have high compression efficiency, high surge stability and wide flow range. It shall be capable to keep dynamic balance in high speed revolution and shall be suitable for transmission of power and safety factor at critical speed. It shall be directly connected with the motor shaft without any coupling. The inlet to the Impeller Compartment shall be open without any restrictions like fins etc.

Integral Variable Frequency Drive shall be air cooled.

Control panel can be integrated / separate from Blower panel. In case, control panel is separate from Blowers it shall be kept in an A.C room.

Motor shall be high-speed Permanent Magnet Synchronous Motor (PMSM). The Shaft of the Motor shall be of Titanium and shall be directly connected to the Impeller.

Motor, being high-speed, shall be provided with the best suited Cooling System to ensure consistent motor output and longevity. All motors shall be air cooled, with an insulation class-H.

Blower shall be equipped with Blow-Off Valve with Silencer.
Controller shall have 16-bit color touch screen with convenient user interface to support various operation modes such as Auto Flow Mode, Auto power mode, Auto RPM Mode, Auto Pressure Mode, Proportional Mode, DO-Link Mode and Failure, Check and Reset Option.

Following measurements and operating data are shown on the Controller Screen:

(a) Operating State of the Turbo Blower:

Ready
Run
Stop
Wait
Error

(b) Measurement and Display Data:

Suction Filter Differential Pressure
Suction Temperature
Discharge Temperature
Discharge Pressure
Suction Flow Rate
Revolution per Minute

Power

(c)Warning and Error Message:

Filter differential Pressure Over
Motor overheating
Compressor Surge
Discharge under pressure
Discharge Over pressure
Suction Over temperature
Inverter Error

Head for blowers shall be decided on the basis of S.O.R. of diffusers and maximum liquid depth in Basin duly considering the losses governing point of delivery (diffusers) and the blowers.

The operation of Aeration System shall include PLC based control. The operation and speed of Air Blowers shall be automatically adjusted using parameters like Oxygen Uptake Rate, Dissolved Oxygen and Temperature and Liquid Level in the Basin such that the DO is supplied as per demand and power utilisation for operation of Air Blowers is optimised.

The main Air Header/Ring Main shall be in SS316 construction. The Air Header/Ring Main shall be supported on saddles at suitable intervals or shall be protected against external corrosion in case laid below ground.

The Sub-header shall have Auto Valves to facilitate switch over of Aeration Cycle from one Basin to other by PLC. The Sub-header shall supply air to fixed type Diffuser Grid through vertical Air Supply Pipes.

Junctions between horizontal Sub-header and vertical Air Supply Pipes shall be suitably protected against corrosion due to dissimilar materials.

The Air Blower House shall be equipped with Forklift of suitable capacity or EOT Crane with Travelling Trolley to facilitate lifting / removal / transportation of Air Blower for repair and maintenance as required.

All the accessories shall be complied as per specification mentioned in Centrifugal single stage blower.

Material of Construction:

Sl. no.	Description	Material of Construction
a	Bearing	Inconel
b	Casing	Aluminium Alloy
c	Impeller	Aluminium Alloy (AL7075)
d	Shaft	Titanium Alloy
e	Blower & Control panel Enclosure	SPHC (Hot Rolled Steel Plate)
f	PLC Hardware	Conformal Coated
l	All connecting accessories and anchor bolts	AISI 316

8.15.2 Centrifugal single stage Blower:

a) The blower shall be of single-stage centrifugal, and shall be designed integral type. The flow rate should be adjustable by controlling the rotation speed with frequency converter or inlet vane or discharge guide vane according to the inlet temperature and differential pressure to ensure the optimal power consumption. Regulation should be possible in the range of 100-50% of the specified design flows at all project design temperatures and at design pressures.

b) The regulation should be fully automated and contain a program for continuous optimization of blower efficiency with respect to changes in inlet temperature, differential pressure and required flow.
c) The pressure grade of the blower casing shall be minimum PN10.The casing shall be cast and bolted together and allow the impeller to be removed with the casing in situ.

d) The impeller shall be open radial flow type (with backward leaning) and made of aluminium alloy, all surface of the vanes should be finish machining.

e) High frequency, variable rotation speed and air-cooling motor should be adopted. The impeller and cooling fan should be directly connected with the motor shaft.

f) The motor shall be equipped with magnetic bearings (If required), which should have the characteristic of magnetic suspension and continuous variable rotation speed. The motor should be installed at a frame with flexible fastening devices.

g) Two radial magnetic bearings and one axial magnetic bearing shall be orientated accurately via the active-bearing controller controlling the rotor. The active bearing controller shall be powered by one DC and one 3 phase AC input. The service life of all bearings should be more than 100000 hours.

h) Appropriate cooling arrangement shall be provided at the blower discharge line so as to bring down the outlet air temperature within tolerable limits, so as to safeguard the life of fine bubble diffusers and satisfactory performance of the same. This cooling arrangement is mandatory with all types of Blowers.

i) The local control cabinet should be equipped with display screen and keypad unit. The running state of the blower should be able to monitor at real time. The displayed data at least include the following:
• Actual flow (%)
• Running time (hour)
• Running time (day)
• MWh counter
• Differential pressure
• Reference flow (%)
• Model of the blower
• Power frequency of the motor (Hz)
• Current (A)
• Transition temperature
• Motor temperature

j) When operating, if the control system finds fault, the blower will give an alarm automatically or stop and the fault code will be displayed at the control cabinet. All signals can be transferred to the control centre of the plant.

k) The blower should have the following protection functions (but not limited to):

• Over voltage of the main power supply
• Under voltage of the main power supply
• I-phase fault
• Over voltage/Under voltage of the auxiliary power supply
• Inlet and outlet air pipe blocking
• Air temperature is higher than the specified limited temperature
• Cooling air temperature is high than the specified limited temperature

Accessories

a) Inlet filter and silencer:

Each blower shall be provided with an inlet filter/silencer mounted directly on the inlet of the Blower via a flexible connection. Such mounting is for the purpose of reducing pressure drop across the inlet appurtenances and of minimizing noise from pipes. Filter/silencer housing shall consist of stainless steel plate and acoustical sound-deadening material on the inside.
Filters shall be removable through easily accessible doors and have very high removal efficiency and shall be sized for maximum face of velocity of 2m/sec at peak air flow.

b) Discharge Flex Connector:

Each blower shall be provided with discharge expansion Bellows joint of SS316. The expansion joint shall alleviate stress caused by thermal expansion and contraction in the piping system. The expansion joints shall be capable of withstanding the pressure under all operating conditions and shall be rated for temperatures up to 160°C.

c) Discharge Cone Diffuser Silencer:

Each blower shall be supplied with a combined discharge cone diffuser-silencer to increase the discharge from the blower outlet to the discharge pipe, thus reducing the air velocity to max. 20 m/sec. The length of the discharge cone shall be aerodynamically designed in order to recover dynamic pressure head and minimize discharge turbulence. The discharge cone shall be constructed of stainless steel plate and acoustical sound-deadening material on the inside, with flanges, and be equipped with a stud for a possible measuring device.

d) Blow-off (Bypass) Valve:

Each blower shall be provided with a blow-off valve to allow unloaded start-up and unloaded stop. The valve operator shall be motorized, equipped with open/closed limit switches, and shall be suitable for air service at 200°C operating temperature. Controls for the valve shall be mounted in each local blower control cabinet with indicating light.

e) Blow-off silencer:

Blow-off silencer shall be provided for each blower and mounted on the discharge by-pass line. The blow-off valve silencer shall be constructed of stainless steel and contain sound absorption material encased in an outer shell. The silencer shall have one sleeve inlet connection for mounting onto the end of the bypass line.

f) Discharge check valve (Back-flow Barrier):

Each blower shall be provided with one discharge check valve flange ends located in the discharge side pipe work, spring loaded butterfly design for mounting between flanges according BS EN 1092-1/BS: 4504. The pressure losses of the fully open valve must not exceed 1.0 kPa. The valves shall be rated for temperatures up to 160°C.

g) Noise Protection Cover:

The blower and motor should be covered with one Acoustic cover, which should be equipped with electric cooling ventilator.

h) Base plate and anchor bolts:

Each blower unit shall be furnished with a frame of adequate size to support the blower, motor, magnetic bearing controller frequency converter, control cabinet and other accessories. The base plate shall be constructed of fabricated steel, provided with lifting lugs and of sufficient rigidity to permit lifting by a fork-lift, with all equipment mounted, without distortion or other damage to the base plate or to components parts of the machinery.

Material of Construction:

Si. No.	**Description**	**Material of Construction**
a	Blower Housing& Gear Box	CI IS 210 Gr. FG 260
b	Impeller	Stainless steel having high structural strength /Aluminium alloy material
c	Shaft	Carbon Steel (High Tensile) EN 19
d	Base plate	MS Profiled steel
e	Inlet filter, silencer casing	Hot Dip Galvanised Steel Sheet
f	Acoustic enclosure	Al-Zn coated steel, insulated with glass wool
g	Blow-off silencer and motor cooling silencer	Hot Dip Galvanised Steel Sheet
i	Inlet cone extension	Hot Dip Galvanised Steel Sheet
j	Coupling	Alloy Steel
k	Air Foil/Magnetic Bearing Body, Cooling Fan	High Strength Aluminium alloy material
l	All connecting accessories and anchor bolts	AISI 316

Si. No.	**Description**	**Material of Construction**
m	Base plate	MS Profiled steel

Control

The control system of the blower should be well connected with the control system of the whole plant. All the real time monitor and protection function shall connect with the control software; the remote control shall be carried out with 4-20 mA or network.

Local control panel and control cabinet shall be combined, that include display screen and keypad, main switch and lock stop push button. The blower operation shall be controlled by the main running switch and keypad.

Performance Guarantee:

The Performance of the compressor shall be guaranteed according to the requested project design values subject allowed tolerances on Flow & Pressure: +/- 0%, and Power: 2%.

Compressor or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.

8.15.3 Submersible Mixer

(a) The submersible mixer shall be installed in the specified plant areas, and they shall be capable of providing a velocity gradient in the range of 500 to 1000 mm/sec. The mixers and power supply cables should have excellent water tightness and abrasion resistance.

(b) The mixer shall have a self-cleaning propeller optimized for effective mixing and vibration-free running, and required power shall be at least 10Watt/m^3 of tank volume.

(c) The mixer shall be driven by a submersible high efficiency 3 phase motors IP 68 Class H. Motor shaft and rotor shall be dynamically balanced.

(d) Bearings shall be lubricated-for-life with a calculated life of more than 100,000 operating hours.

(e) Power supply cable shall be secured such that it is not affected by the mixing flow, cutting with a stirring propeller or deflection.

(f) The mixers shall have the flexibility to be located at different depths and thereby avoiding dead zones.

(g) The mixer shall be provided with the following:

(1) Lifting frame with a winch which can be dismantled, free standing with adjustable boom length.
(2) Mounting socket for free standing hoist suitable for wall mounting.
(3) Guide for floor fixing components and support brackets for wall mounting.

(4) Stainless steel (SS316) rope for raising and lowering the mixer.
(5) Rope block for holding the stainless steel 316 rope where the lighting frame is used in different locations.
(6) Support rope for reliable support and guidance of power supply cable.
(7) Support clamps and hooks to support the power supply cable in such a manner that it is not under strain.
(8) The propeller, and motor housing, guide pipe, support brackets and all fasteners shall be of SS 316. The propeller shaft shall be of SS 431.The Lifting winch & Davit shall be of galvanized steel construction.

8.15.4 Rotary Air Blowers

(a) Compressor blowers shall be of the rotary tri lobe positive displacement type, each provided with inlet filter and silencer, pressure reducing valve, pressure gauges, pressure relief valve, drain, air flow indicator and acoustic bend or silencer in the delivery branch. Bearing housings and gear boxes shall be separated from the blower housings by air spaces. The units shall be complete with a self-contained oil cooling system for the bearings. The blowers shall be housed inside acoustic enclosure. The noise level shall not exceed 85 dBA at 1 meter from the Blower.

(b) The bearings shall be generously designed to give long operational life. Bearings at the drive end may be oil or grease lubricated. The gears and bearings at the non-drive end shall be oil lubricated. Bearings shall be lubricated for life with a calculated life of more than 100,000 operating hours. Bearings shall be provided with oil throwers to prevent leakage of oil. The blower shall be arranged for horizontal inlet and vertical outlet, delivery velocity not exceeding 20 m/s and each blower shall be provided with following components but not limited to:

(1) Common base frame for Blower & Motor.
(2) Inlet silencer and filter.
(3) Discharge Silencer & non-return valve in delivery branch.
(4) Motorized Butterfly valves in both inlet and delivery branches with metal-to-metal sealing.
(5) Pressure relief valve or excess pressure safety device.
(6) Bellows SS 304 type couplings on inlet and delivery piping & on suction & delivery silencers.
(7) Acoustics Enclosure.
(8) V-Belt drive arrangement with Belt Guard.
(9) Isolating valves, Pressure reducing valves & Pressure gauges
(10) Air Flow meters, Temperature gauges.
(11) Water trap.
(12) Gravel filter.

(c) The interconnecting pipe work shall be flanged to BS EN 1092-1/BS: 4504. A drain cock shall be provided at the lowest point in each delivery pipe work along with reflux valve. Individual stop valves and safety valves shall be provided for each unit.

(d) Blowers shall be driven by squirrel cage motors through a matched V-belt drive. Motors shall be mounted on slide rails mounted on a common bed plate, to facilitate the tensioning of the belts. Blowers shall not run above 1000 rpm and prime movers also.

(e) Each delivery branch shall include a drain at the lowest part and a reflux valve.
Each blower shall contain one inlet air pressure, one discharge air pressure, and one discharge air temperature gauge. The pressure gauges shall be calibrated in kPa absolute and be of the compound type. The gauges shall have circular dials, minimum 100 mm diameter with black figures on white background. Pressure gauges shall be furnished with pulsation damper. Temperature gauges shall be manufactured with standard temperature bulb.

(f) Appropriate cooling arrangement shall be provided at the blower discharge line so as to bring down the outlet air temperature within tolerable limits, so as to safeguard the life of fine bubble diffusers and satisfactory performance of the same. This cooling arrangement is mandatory with all types of Blowers.

	Description	**Material of Construction**
a	Blower Housing	Backwash Air application: CI IS 210 Gr. FG 200 or 220 Biogas flare, Biogas Scrubber and Engine & Boiler feed: Stainless Steel ASTM A 743 CF 8M
b	Lobes	Backwash Air application: CI IS 210 Gr. FG 200 or 220 Biogas flare, Biogas Scrubber and Engine & Boiler feed: Stainless Steel ASTM A 743 CF 8M
c	Shaft	Carbon Steel (High Tensile) EN 19
d	Base plate	MS fabricated Epoxy painted
e	Inlet filter, silencer casing	Galvanised Steel
f	Acoustic enclosure	Al-Zn coated steel, insulated with glass wool
g	Blow-off silencer and motor cooling silencer	Galvanised Steel
i	All connecting accessories and anchor bolts	AISI 316
j	For Biogas application: All blower parts which are in contact with Biogas shall be of SS316/ CF8M only.	

8.15.5 Acoustical Enclosure

(a) Provide a factory assembled acoustical enclosure around the entire blower. Disassemble the enclosure as necessary for shipment. Provide either removable or hinged doors for access to all blower parts and components for servicing and maintenance. Size access panels to allow easy access by a single operator. Hinges, fasteners and appurtenances shall be stainless steel.

(b) Provide clear, transparent Lexan or plastic windows to visually observe gauges and lever arms.

(c) Mount an auxiliary exhaust fan and thermostat on the acoustical enclosure to provide air circulation after blower shutdown or when the temperature inside the enclosure exceeds 40°C.

(d) The free field A-weighted sound pressure level measured in four quadrants at 1 metre distance from the enclosure shall average 85 dBA, or less. Measure with a Type 1 instrument suited for checking compliance with Environmental and Occupational Noise Rating Recommendations.

8.15.6 Motors for Biogas application area

Motors shall be squirrel cage type conforming to IS 325. The power rating shall be at least 125% of maximum power requirement. The other features of motors shall be as follows :

- ✓ Type of duty : Continuous (Sl)
- ✓ Method of starting : Star-Delta
- ✓ Class of insulation : F (Temperature rise limited to class B)
- ✓ Type of enclosure : TEFC and Flame proof
- ✓ Degree of protection : IP 55

8.16 Dewatering Centrifuges

(a) When the excess sludge with insufficient flocculation is concentrated with mechanical thickened, phosphorus is not released from the sludge because the concentration time is short.

(b) The Dewatering Machine and its peripheral equipment shall include but not necessarily be limited to the following;

(1) Powder or liquid Coagulant storage tanks.
(2) Mixers and solution tanks.
(3) Coagulant service tanks.
(4) Supply line & flush line.
(5) Chemical feeding pumps.
(6) Water supply pumps.
(7) Sludge feeding pumps.
(8) Dewatering Centrifuge
(9) Screw / Belt conveyor.
(10) Cake hopper.
(11) Flow meters for feeding Sludge, and for feeding chemical solution.
(12) Control valves on sludge feeding line, and on Chemical feeding line.
(13) Drain system

(c) Dewatered cake shall be conveyed by a screw conveyor to cake hopper for carrying out for reuse. The performance of the centrifuge shall be taken into account the conditions necessary for dumping the dewatered cake to the waste disposal site by a truck.

(d) To select the type of dewatering machine, Contractor shall provide technical information to show client that performance to obtain his approval in advance.

(i) Decanter Centrifuge

The centrifuge shall comprise a conical cylindrical bowl and scroll feed horizontally mounted in bearings on a frame. The centrifuge bowl and scroll support frame shall be mounted on a fabricated steel sub-frame.

The bowl and scroll shall be made from stainless steel AISI 316 material. The leading faces of the scroll shall be protected against abrasive wear by the application of a suitable hard-coated material (Tungsten carbide).

The whole rotating assembly shall be enclosed by a Stainless steel (AISI316) fabricated casing incorporating a Centrate discharge hopper and outlet pipe, and a rectangular solids hopper which shall discharge the dewatered sludge into the disposal system.

The rotor shall consist of a solid bowl which is conical-cylindrical in shape and which rotates about a central shaft. An inner scroll shall be provided to convey separated sludge from the periphery of the cylindrical bowl to the beach at the conical end of the rotor.

The main scroll bearings shall be arranged for lubrication by an external lubrication system. Wherever practicable greasing nipples shall be arranged together as a battery. The complete rotating assembly shall be dynamically balanced and test certificates provided.

Sludge shall be fed into one end of the rotor through a centrally positioned feed tube and dispersed to the bowl through an inlet chamber.

The bowl shall be provided with an adjustable 360^{o} peripheral weir at its cylindrical end to control the depth of the Centrate in the rotor.

The fixed outlet castings of the rotor shall be designed to collect the centrate and dewatered sludge from the rotor. Baffles within the casing shall direct the separate phases to the relevant discharge points and prevent cross-contamination.

The centrifuge shall be mounted on heavy-duty vibration isolators, located between the machine and the supporting steelwork or foundations, to damp vibrations and prevent vibration transmission. Two axis vibration monitors shall be provided to stop the centrifuge automatically when excessive vibration is detected.

Flexible connections shall be provided on the sludge fed system and the Centrate system at the centrifuge. The dewatered sludge discharge system shall incorporate flexible chutes.

(ii) Variable Speed Drive

A variable speed drive shall be provided to accelerate the rotor to operational speed and maintain that speed during the centrifuge's duty period. The bowl drive shall be electric or hydraulic and shall be coupled to the drive shaft by a multiple 'V' notch belt drive.

(iii) Differential Scroll Drive

The scroll drive shall be provided with a separate drive mechanism to control its rotation in the same direction but at a different speed to the outer bowl. The differential speed shall be adjustable. The Centrifuge shall have both front drive and Back drive mechanism.

The drive shall be linked to the main bowl drive by an epicyclic gearbox. The differential speed of the scroll shall be automatically and manually adjustable so that the moisture content of the dewatered sludge can be controlled as required.

For safe operation, contractor shall provide control panel showing proper Sequence of operation with interlocking.

Chutes and interconnecting piping shall be provided with flexible joint (minimum 10 mm flexible in all direction) to avoid vibration.

8.16.1 Conveyor System

(a) For the disposal of sludge a common motor driven endless belt conveyor shall be provided. The conveyor shall be designed in accordance with IS 11592 or equivalent. The conveyor and chutes shall be suitable for handling occasional heavy objects which will cause shock loads.

(b) The construction of the frame and support shall be robust and torque resistant. Belt conveyor shall be of 20 deg. Trough type complete with drive assembly structures, idlers, pulleys and belt cleaners. Idlers and pulley shall be provided with anti-friction bearings.

(c) The belt material shall be two ply nylon or equivalent with minimum 3 mm neoprene covering on carrying side. Splicing shall be employed to make the belt endless. The belt shall operate over three roll twenty degree, troughing idlers. The idlers shall rotate on precision type, deep groove, and single row ball bearing with built-in close fitting triple labyrinth grease seal. The ends of the outer shell shall be counter bored and a full length centre tube journalled concentricity. The outer shell, centre tube and precision die formed steel ends shall be brazed into an integral unit to provide concentricity. The ends of the centre tube shall be bored concentrically with each other after roll assembly to provide correct bearing alignment and to provide prestressing of boring. The centre tube shall be grease fit after assembly. Troughing idlers shall have means of adjustment or ensuring belt tracking. On the return run the belt shall operate over flat roll idlers having bearing, shaft and lubrication arrangements as above for carrying idlers. Spacing of idlers shall be of 1200 mm on carrying run and 2400 mm on return run.

(d) The head and tail pulleys shall be manufactured from welded steel/any alloy steel and shall be provided with rubber lagging. Lagging for drive pulleys shall have herringbone grooving. Pulleys shall be equipped with taper lock bushings. The tail pulley shall incorporate a screw rake for adjusting belt tension. Head and tail pulleys shall be adequately guarded.

(e) Shafting for pulleys shall be of heat treated carbon steel. They shall be forged, ground and polished to obtain close diameter tolerances. The head shaft shall be provided with roller bearing pillow blocks.

(f) The belt conveyor shall be driven by a squirrel cage, TEFC motor. A V-belt drive arrangement shall be provided between the motor and a helical speed reducer, the latter shall be mounted on the end of the head shaft. The driving pulley shaft shall have back stops to prevent backward movement of the belt.

(g) The conveyor shall be supported on appropriate channel sections with 14 gauge steel deck plate between the two runs of the belt and the necessary supports to the floor. The floor supports shall be made out of steel plates having minimum 6 mm thickness. The conveyor shall be protected from weather by a 'dog box' type canopy.

(h) An adjustable belt scraper shall be provided on the hopper end of the conveyor belt. The scraper and attachments shall be of fibre reinforced plastic.

(i) Sludge cake discharge Hoppers shall be provided to transfer the sludge cake from the Centrifuge to the troughed belt conveyor and from the conveyor discharge to skip. The latter chute shall extend beneath the belt scraper and shall allow access for maintenance of the belt scraper. Chutes shall be designed to minimize the accumulation of rags and stringy materials. The sludge cake hopper shall be of MS fabricated with minimum 10 mm thick corrosion resistant painting applied, and it shall be operated by a motorized cut gate for auto operation with load cell arrangement in the plant. The cake hopper minimum dewatered sludge holding capacity shall be at least for 2 hours.

The conveyor shall be fitted with an emergency stop operated by wire rope at foot level. Two Nos. belt sway switches shall be provided on conveyor

8.17 Progressing –Cavity Pumps

(a) Pumps shall be of the type in which a pumping action is generated by a helical rotating eccentrically within a resilient stator in the form of a double internal helix. The eccentric motion of the rotor shall maintain a constant seal across the stator as it travels through the pump to give a uniform positive displacement.

(b) Pumps shall be arranged generally with a single shaft seal at the suction end. Mechanical seals shall be used. If a flexible shaft is used to accommodate the eccentric motion, a corrosion resistant shroud shall be fitted to prevent fiber build-up on the shaft. Enlarged inspection access holes shall be fitted to the suction chambers of all pumps for periodic removal of accumulated debris. The shaft bearing shall be positively isolated from the fluid being pumped.

(c) The rotor material shall be selected for corrosion and abrasion resistance for the fluid being pumped, and for prolonged service life. Hard chrome or other approved coatings shall be not less than 250micron thickness and shall be diffused in to the base material. The rotor shall generally be single-stage and shall incorporate not less than 360^0 of twist, but for high-head applications, it may be necessary to use more than a single-stage. The stator shall be of a resilient material selected for chemical and abrasion resistance for the fluid being pumped. Pump speed shall suit the application, where variable delivery output is needed; the pump shall be provided with a variable-speed drive. The size and speed

range of the pump shall ensure that the highest expected duty point shall lie within the available speed range.

(d) Pumps shall normally be driven by a fixed-speed electric motor through reduction gearing and the combined drive shall be continuously rated. Pump and motor shall preferably be mounted in-line on a common base plate. Alternatively, the drive motor may be top-mounted above the pump to minimize floor area, and shall be connected by external V-belts and pulleys. V-belt drives shall have full guards of the type that allow the belts observed without removal of the guard. Facilities shall be provided for ready adjustment of belt tension.

(e) Coupling guards shall be provided, which shall be rigid, securely fixed, and designed so that removal is not necessary during normal operation, routine maintenance and routine inspections.

(f) All motor enclosures shall be provided with ingress protection to IP55. Motor anti-condensation heaters shall be provided and shall be suitable for use on a 220V single-phase, 50Hz supply. All bearing shall have a B10 design life of not less than 40,000 running hours and shall be designed for loading 20% in excess of calculated maximum loading.

(g) Pumps shall be fitted with individual dry-running protection to initiate pump trip. Dry-running protection by 'under-current' monitoring or 'pipeline-intrusive' device shall not be used.

Material of Construction;

S. No.	Component	Material
1	Pump Housing	CI IS210 Grade 260
2	Rotor & Coupling & Connecting Rod	SS AISI 316(HCP) 250 Microns
3	Shaft	SS AISI 410(HCP) 250 Microns
4	Stator	Nitrite black
5	Type of drive	V belt & Pulleys
6	Base plate	MS fabricated
7	Mechanical seals	oil-lubricated with tungsten carbide or silicon-carbide faces

Pumps models (handling water) shall be selected such that when handling sludge it meets the required duties of the viscous liquid. Pumps shall be selected which gives the required duties close to best efficiency point.

8.18 Chlorination System

Chlorine solution diffusers shall be supplied and installed at the dosing point.
Treated sewage shall be dosed with chlorine gas at concentrations not more than 5 mg/l during average flow and 10 mg/l during peak flow. Effluent from the chlorine contact tank shall not have more than 1 mg/l of residual chlorine at discharge point.

Each Chlorinator set shall consist of following as a minimum:

- Wall mounted Front operated ABS Molded Cabinet

- Remote Vacuum regulator (ABS Molded) - 1 Nos for each plant

- Injector Assembly with check valve (ABS Molded)- 1 Nos for each plant

- Chlorine flow-meter (Rota meter) (ABS Molded – Mounting inside cabinet) - 1 Nos for each plant

- Diff. pressure regulator (ABS Molded – Mounting inside cabinet) – 1 Nos for each plant

- Secondary Check Valve (ABS Molded – Mounting inside Cabinet) – 1 Nos for each plant

- Drain Valve (ABS Molded – Mounting inside Cabinet) – 1 Nos for each plant

- Chlorine rate control valve (ABS Molded – Mounting inside Cabinet) - 1 Nos for each plant

- Vacuum and vent tubing as per requirement. - 1 Nos for each plant

- Yoke Clamp - 1 Nos for each plant

- Yoke Clamp with adaptor for copper pipe - 1 Nos for each plant

- 63mm Vacuum Gauge - 1 Nos for each plant

- 63 mm Water Pressure Gauge On Ejector Inlet - 1 Nos for each plant

- Required copper tubing - 1 Nos for each toner connection (Toner Connection qty. shall be as per capacity of chlorinator & 1% withdrawal rate of chlorine gas from single toner)

- PP Isolation ball valves on Inlet/Outlet of Ejector of suitable size - 1 set for each plant

- PP Isolation ball valves on Inlet/Outlet & interchangeable of Booster pump of suitable size - 1 set for each plant

- Y type strainer on raw water inlet of booster pump of suitable size - 1 Nos for each plant

- PP NRV on ejector outlet line of suitable size - 1 Nos for each plant

- Each set shall also comprise of all standard accessories, sub assembly that is required for smooth operation of chlorinator and to complete the system. In addition to above chlorinators following shall be supplied in quantity as specified as a minimum or higher as required to complete the system:

- Chlorine Pressure Gauge (Monel wetted part MOC only) – 1 No. for each gas filter inlet & outlet

- Centrifugal Booster Pumps of adequate capacity/rating – 1 Nos for each plant

- Required length of uPVC piping and pipe fittings along with PP/PVC valves/ NRV/ Strainer, etc. for connecting suction and delivery piping, as applicable, including interconnecting pipe/valves at delivery side of booster pump to chlorinator and main piping to feed water to any chlorinator.

- CS Gas Manifold suitable for sufficient toner connection and chlorinator connection and shall be as per ASTM-106 Gr. B with minimum 6000 LBS Fittings

- CS Gas filter (Moisture Trap) – 01 no. for each gas manifold

- Valves for CS manifold as per IS:3224 – as required

- Diffuser – 1nos.

- suitable size of uPVC pipes and fittings for chlorine solution in required length to connect chlorinators with 1 nos. diffuser along with all interconnecting valves at both ends – 1 Lot

- MS Skid as required – 1 Lot

- Necessary automatic safety devices like gas-off-etc. in case of emergency like failure of power, water supply, should be incorporated. Further safety devices for backwater entry in chlorinator due to failure of NRV should also be incorporated, as applicable.

There is complete set of chlorination plant and supply of items as per GA drawing & price bid submitted with this tender document. Each plant shall consist of chlorinator with a submersible mono block pump, which shall provide pressurized water to the chlorinator. The water and chlorine solution shall be injected in the sump at suitable locations. The pump shall be suitably located within the sump, which shall be approximately 6 m deep

The chlorinator shall be generally as per IS: 10553 (part 2) of 1983 and Chlorine Institute of USA and suitable to provide continuous and constant measured quantity of gas while in operation. Intermittent start or stop control or automatic shut off of chlorine shall be possible in case of leakage in the piping or interruption of water supply.

In the event of development of excessive gas pressure in the system due to any reason, it shall be safely vented. In order to vent off any excess vacuum, relief valve shall be included in the system, which will admit air to release any excessive vacuum, which may develop. The location of the vacuum relief valve shall be such that the air admitted in the system will not pass through flow meter. Therefore, flow meter will indicate only gas flow.

DESIGN REQUIREMENTS

All pressure gauges shall be provided with isolating valves.

The velocity in the pressure water lines shall not exceed 2.0 m/sec.

Gas filter shall be capable of holding all the solid particles with readily removable glass wool cartridges or equivalent materials.

Chlorine stop valve shall be as per IS:3224 isolated from the gas and shall have needles and seats of easily replaceable type.

Gas flow meters shall be calibrated in metric units.

All components in contact with chlorine shall be of suitable material to withstand corrosion.

All spring shall be used in the vacuum regulator shall be tantalum alloy.

8.18.1 Chlorinators

Chlorinator shall be Vacuum Type Solution Feed Wall Mounted Chlorination system consisting of a Floor/Wall mounted cabinet with in-built chlorine flow meter with chlorine rate control valve, interconnecting vacuum piping, with Remote vacuum regulator, Remote injector with primary check valve, vent and vacuum tubing, yoke clamp, etc. complete in all respects and with highest safety standards and as per Chlorine Institute standard, USA. MOC of piping, valves and accessories for chlorination system shall be strictly follow as per various pamphlet of Chlorine Institute, USA. Entire chlorination plant shall consist of all components and each and every parts of Chlorinator must be moulded foam, no machine made allowable.

(a) Chlorinators shall be free-standing, floor-mounted ABS/PVC molded cabinet, and shall have a turn down ratio of 10: 1 over the full range of works operation.

(b) Vacuum type chlorinators shall be supplied with one duty and one standby unit.

(c) Each chlorinator shall be equipped with a motorized plug positioned to be actuated by a sewage flow at the works outlet.

(d) The dosing rate shall be manually set and each chlorinator shall be equipped with a 0 to 10 mg/l scale and a manual dose setter over the complete range.

(e) Mal-operation of the duty chlorination system shall be indicated in the chlorination room and the central MMI. The change to the standby system shall be carried out automatically in the event of a duty chlorinator failure.

8.18.2 A: Motive water pumps and Injector

(a) Motive water pumps (1 working + 1 standby) shall be installed in chlorine building.

(b) The pumps shall draw their supply from bore well/plant water supply.

(c) The pumps shall be installed outside the chlorination room and shall be made from material resistant to corrosion by chlorine.

8.18.3 The Tonner Room

(a) Storage shall be provided for chlorine tonners sufficient for at least one month's usage at normal rates of applications

(b) The system shall be designed to prevent freezing of the liquid chlorine at the maximum rate of withdrawal.

(c) Tonners on line, tonners on standby and full and empty tonners, shall be stored separately in the tonner room.

(d) Sixteen sets of tonner rollers shall be provided. Tonners not in use shall be stored on concrete cradles.

(e) A 3-tonne overhead EOT crane shall be provided in the chlorine tonner room for the following functions:

(1) Offloading (and reloading) of tonner from trucks;
(2) Handling of tonners within the storage area.

(f) The system shall serve the tonner store width over the entire length and width including the loading/ unloading area.

(g) The hoist and traverse speeds shall be as follows ;

(1)	Long traverse speed	:	5m/min
(2)	Cross traverse speed	:	5m/min
(3)	Slow lifting speed	:	1m/min
(4)	High lifting speed	:	5m/min

(h) The container lifting beam shall be specifically designed for handling chlorine containers and equipped with necessary shackles and hooks.

(i) Operation of EOT Crane shall be from the floor level using independent push button pendant controls operating at a 230 volt 50 Hz AC supply.

(j) One lifting beams shall be provided (a duty and a spare) and a one tonner weigher to be suspended from the crane.

(k) When the pressure in the duty chlorine tonner falls to less than 1 kg/cm^2 the automatic changeover device shall operate to isolate the empty tonner and to bring the full standby tonner on line.

(l) A pit and alkali absorption system shall be provided to contain and neutralize chlorine in the event of a leak. The system shall comprise a pit located in the tonner storage room, suitable pump in SS CF8M material and accessible by the overhead crane system. The pit shall be surrounded with removable guard railing. The pit shall be kept full with a neutralizing solution of lime. The pit shall be capable of holding side by side two chlorine tonners. A provision shall be made to drain the pit.

(m) In addition to the above Automatic chlorine leak absorption system (Gas Scrubber with NaOH dosing) shall be provided adjacent to the Tonner room. The process shall be designed to contain and neutralize chlorine gas vapors in response to gas leak or catastrophic cylinder failure. The system should be able to absorb 99.99% of the chlorine gas entering the scrubber.

(n) When a leak occurs, the pump and fan shall start automatically. The fan shall provide sufficient vacuum to contain the chlorine gas and deliver it to the scrubber. The pump shall circulate the concentrated caustic solution over the scrubber packing to absorb all the chlorine gas. (Blower & Pump must be 1W+1S basis)

(o) Special consideration shall be given to any floor drainage system in the tonner building; adequate traps shall be provided to ensure that chlorine gas cannot escape. All leader tubes carrying cables or pipes out of the building shall be sealed at either end to prevent any chlorine gas leaking out.

8.18.4 Chlorination Room

(a) The chlorination room shall be constructed adjacent to the tonner room but with no interconnecting door or other form of access.

(b) Gas lines from the tonner room into the chlorination room shall run in ducts to be sealed after installation and prior to commissioning.

8.18.5 Chlorine Leak Detectors

Not less than three chlorine gas leak detectors shall be provided each, with a single detector cell. At least two sensors shall be located in the chlorine tonner storage room and at least one sensor in the chlorination room. The chlorine leak detectors in the tonner room shall be mounted at each end of the tonner room.

a) The chlorine leak detectors shall have two adjustable alarm levels sensitive to chlorine concentrations above 1 mg/m3. The range of adjustment of alarm levels shall facilitate selection of the following alarms:

(1) low level 2 mg/m^3
(2) high level 4 mg/m^3

The low level alarm shall:

(1) Initiate a local audible and visual alarm;
(2) Start the ventilation fans in the tonner and chlorination rooms;
(3) Raise an alarm at the local control panel and at the central MMI.

The high level alarm shall:

(1) Initiate local audible and visual alarm;
(2) Initiate audible and visual alarms outside the buildings (the alarm shall be sufficiently loud to be heard in all buildings at the STP);
(3) Raise an alarm at the local control panel and at the central MMI;
(4) Shut down the chlorination systems;
(5) Start the tonner room and chlorination room floor level exhaust fans. Fans to stop once high level alarm and low level alarm are stopped.

(b) The chlorine detectors shall have self-checking circuitry and detector failure alarms shall be provided at the local control panel and central MMI.

(c) Detector failure alarms shall not be combined with the leak alarms.

(d) Statutory warning notices relating to the storage and handling of chlorine shall be provided. The signs shall be pictorial and provided in Kannada and English.

8.18.6 Ventilation System

(a) Each area where chlorine is stored or used as gas or liquid shall be provided with a forced ventilation system.

(b) Air intakes shall be sized to allow uniform ventilation and positioned to prevent possible recirculation.

(c) Exhaust air shall be ducted from low level and discharged at high level.

(d) An air change rate of four per hour under normal condition and a minimum of twenty changes of air per hour under shall be used in the event that a chlorine leak is detected.

(e) Exhaust fans shall be heavy duty industrial pattern manufactured from chlorine resistant materials.

(f) Ductwork (Minimum 400mm ID) shall be manufactured from Aluminum sheets/PP (3mm) +FRP (5mm) in circular or rectangular sections.

(g) Ducts shall be designed in accordance with relevant Indian standard specifications.

(h) Fan controls shall be linked to the gas leak detection system.

(i) Hardwired fan controls shall be provided and shall be manually controlled. An override shall be provided to operate the fans in the event of a chlorine leak alarm.

(j) Fan controls shall be grouped in an enclosure outside the ventilated area and shall include the following:

(1) fan off/on;
(2) fan running/failed indication lights;
(3) Low and high gas leakage indication alarm light.

8.18.7 Chlorine Residual Monitors

(a) Chlorine residual monitors shall be provided at the plant outlet.

(b) The monitor installation shall be located in a covered location easily accessible for viewing and maintenance and shall be provided complete with sample pumps as necessary to ensure the continuity of the sample.

(c) The sampling pipe work complete with isolation valves etc. shall be designed to ensure the sample reaches the monitor in a time not greater than 1 minute. The monitor drainage pipe work shall permit the visual checking of the presence of flow and shall discharge to the foul drain. Sample sewage not passed through the monitor shall be returned to the process.

(d) The residual signals shall be displayed at the local control panel.

(e) High and low chlorine residual levels shall raise alarms at the local control panel.

8.18.8 Safety Equipment

a) Materials and equipment necessary to ensure the safety of personnel operating the chlorination plant and others shall be provided.

b) The equipment shall include:

(1) Two sets of approved self-contained breathing apparatus, each comprising an air set, carrying harness, face mask and valves and ancillary equipment. Each set shall be provided with three 1200 litre capacity, 140 mm diameter, air tonners;

(2) Two sets of approved positive airline breathing apparatus, each comprising body harness, face masks and valves and 30 m of airline. One air trolley, comprising wheeled frame with two air tonners, control manifold, airline hose and hose winding drum. Two spare tonners suitable for changeover shall be provided;

(3) One portable electric motor driven air compressor for recharging air tonners, complete with quick-release air hose couplings;

(4) Two `instant action' resuscitators.;

(5) Four sets of safety clothing in various sizes, each comprising PVC overalls, wellington boots with steel toe caps, goggles, gloves and safety helmets.

(c) Each set of safety equipment shall be mounted in a glass-fronted, non-locking PVC coated steel cabinet in approved locations on the outside of the building.

(d) Two emergency showers shall be provided and shall be installed outside on either side of the tonner room.

(e) Each shower shall be operated automatically by a quick acting hand or foot valve.

(f) Four eyebaths shall be supplied. Two eyebaths shall be adjacent to each of the showers.

(g) Water for the showers, etc. shall be drawn from the service water supply.

(h) A telephone will be provided close by outside the building for emergencies.

8.18.9 Chlorination Power and Control

(a) A combined MCC and control panel shall be provided and located in a suitable location protected from the weather and the effects of the process. The control panel shall provide facilities for :

(1) Display status and values associated with the chlorination systems;

(2) Duty pump selection;
(3) Annunciate alarms associated with the chlorination systems;
(4) Operator adjustment of process set points.

(b) The chlorination systems shall operate using a fixed manually set dose rate. The quantity of chlorine dosed will therefore be adjusted in direct proportion to the process flow at the dosing point.
(c) The chlorine residual monitors to be provided shall be used for monitoring and alarm purposes only.

THE AUTO SHUT OFF CHLORINE CYLINDER/TONNER VALVE SYSTEM for single chlorine cylinder/Tonner (100/900 kg) shall comprise of following as min.:

01) Pneumatic Auto shut off chlorine cylinder route valve with actuator system with Air line Filter, Solenoid Valve, Air Drive with clutch protection, Yoke clamp, etc. of required capacity, size, rating-1 No. for each toner NON REVERSIBLE CLUTCH TYPE WITH CONTINOUS ROTATION MOTION TYPE
(Note : Pneumatic tools or quarter turn pneumatic actuators or Pneumatic Ratcheting Motion are strictly not allowed)
02) Control panel cum PLC with interconnecting cables/wiring for Auto Shut Off chlorine Valve of Cylinder-1 Lot,
03) Air Compressor - 1 No,
04) uPVC-SCH 40, Air piping for Auto Shut off valve as required -1 Lot,
06) Interconnecting instrument & Power cable -1 Lot

A. Fail Safe Pneumatic Isolation Shut off System for Chlorine Tonner

PNEUMATIC OPERATED AUTO SHUT OFF VALVE OF CHLORINE CYLINDER ROUTE VALVE

Technical Specification:
Supply, Installation, Testing and Commissioning of Pneumatic Auto Shut off Valve with clutch protection System for Chlorine Cylinder to detect and prevent leakage of Chlorine/Hazardous Gas as per manufactures specifications and relevant standards mentioned as under suitable for the system:

Quality Assurance:
Manufacturer's Qualifications:
Manufacturer shall have regularly engaged in the supply of emergency cylinder closure equipment for a period of at least 5 years and shall have proven installation and running track record of 5 years.

Coordination:
Equipment for the emergency cylinder valve closure system(s) specified herein shall be coordinated with associated equipment and devices specified elsewhere to provide complete and fully compatible systems.

The emergency cylinder valve closure system(s) shall consist of the following components:

Closure System Construction

1. Pneumatic operated drive with clutch protection capable of producing no more than 22 ft-lb of stall torque at 90 psig of operating gas pressure. The operating gas pressure shall be adjustable to provide 70 - 120 psig pressure range. The air drive shall require 11.2 SCFM at 90 psig. The Actuator should have clutch provision.

2. The Actuator should have inbuild automatic relief clutch to avoid damage to valve and actuator itself to avoid accidents.

3. The actuator should have inbuild sensor to provide signals of valve closers.

4. The actuator should have facility for variable torque & speed adjustment.

5. Special tools should be provided for clutch adjustment

6. Spring-loaded coupler assembly to couple pneumatic operated actuator to the cylinder valve stem. Travel length of coupler assembly shall allow for varying lengths of cylinder valve stem. Coupler assembly shall be an integral part of the pneumatic actuator.

7. Bracket assembly to hold pneumatic actuator in place during closing of the cylinder valve. Bracket assembly shall use a pin to allow quick disassembly and shall not rely for support on packing nut or yoke assembly, or any other external support. Mounting bracket shall be fabricated from suitable chlorine metallurgy. The fully assembled actuator and bracket shall weigh not more than 7 pounds.

8. The air drive free speed should not be more than 317 RPM

9. Torque adjustment range should be between 5 to 14 Nm

10. Air drive should have auto shut off on access torque.

11. The maximum length of Air drive motor should be below 250mm

12. Anti corrosive sleeving on Air Drive unit should be provided.

13. Air drive unit should have ABS molded enclosure.

14. The air drive unit installation should be tool free.

15. Air drive unit should trigger remotely, it should not have any liver operation.

16. Air drive unit should be state drive and not angle drive.

17. Total drive length along with enclosure and mounting bracket should not exceed 370mm.

18. Maximum weight of air drive unit along with enclosures, clamps should not exceed more than 7 pound.

19. No part of the actuator shall extend more than 4" beyond the plane formed by the rim of a one ton container.

20. The air drive unit should have inbuilt sensor to detect the operation of air drive unit for closure of valve and clutch.

21. A supply hose 6-foot in length and 3/8" inside diameter and quick connect fitting shall be supplied for easy attachment of the pneumatic actuators to the operating gas source.

22. A pre-assembled air control until shall provide filtered air that shall remove debris larger than 5 microns from the operating gas supply. It consists of the following installed components:

23. A Air dirve (Pneumatic actuator) must be ATEX certified.

Reference Standards:

Comply with applicable provisions and recommendations except as otherwise shown or specified. The Chlorine Institute, Inc.

Submittals:

Shop Drawings and Product Data Comply with Section and the supplemental requirements below.
Submit for approval for the following:

- Complete submittal including all connections and internal details.
- Complete description in sufficient detail to permit comparison with the technical specifications.
- Weights and capacities. Wiring diagram for any electrical equipment.
- Manufacturer's literature for all system components including: dimensions, schematics, materials, size, weight, equipment information, and MSDS sheets as applicable.
- Confirm that the equipment is suitable for the service conditions specified.

Operation and Maintenance Data

Comply with Section and the supplemental requirements below.

Submit for approval of the following :

1. Each system shall be submitted as a complete submittal including all connections and internal details.

2. Complete description in sufficient detail to permit comparison with the technical specifications.

3. Weights and capacities. Wiring diagram for any electrical equipment.

4. Manufacturer's literature for all system components, including dimensions, materials, size, weight, equipment information as applicable.

5. Confirm that the equipment is suitable for the service conditions specified.

6. Operation and Maintenance Manuals: Submit complete installation, operation and maintenance manuals including all shop drawings as required by Section

Required Operation Data:

1. Complete operating instructions for each piece of equipment with a moving part
2. Explanations for all safety considerations relating to operations
3. Recommended spare parts list
4. Safety warnings

Required Maintenance Data

1. Recommended schedule of maintenance and inspection tasks
2. Troubleshooting instructions
3. Name, address and phone number of manufacturer and manufacturer's local service representative

Service Conditions

Description: The emergency cylinder valve closure system(s) is to be specifically designed to close the cylinder or container valve(s) as shown on the drawings. This shall be accomplished by using a pneumatic operated drive with clutch protection system directly coupled to the cylinder or container valve. The pneumatic operated drive shall utilize compressed air as a source of operating gas. Electrically operated systems shall not be acceptable.

Operating gas pre filter: This filter shall remove debris larger than 5 microns from the operating gas supply. This filter shall be located in the operating gas supply line upstream from the solenoid valve.

Pressure switch: This pressure switch shall be of normally open configuration. Loss of operating gas pressure shall cause this switch to open and activate a corresponding alarm. Operating range of the pressure switch shall be adjustable.

Air Safety Valve: This valve provides protection for the solenoid valve. This is normally set for 125 psig.

Solenoid Valve: This valve shall be of normally open configuration. De-energizing the solenoid valve shall open the valve, allowing it to supply gas to operate the pneumatic actuators. This unit shall have 1/2" flanged connections to accommodate field installation.

Control Panel

a. The valve closure system shall be furnished with a local control panel with a enclosure to house the required controls. The control panel shall be mounted in the chlorine room or external of the chlorine room.

b. The control panel shall include the following switches and pilot lights emergency stop, reset switch, alarm silence, supply power, air pressure low, system ready, and system activated.

c. All control devices shall be mounted on the front of the control panel enclosure. Each control device shall have an engraved or etched nameplate describing its function.

d. The control panel shall have a terminal strip for connection of power and control circuits in the field. All terminals shall be numbered, and terminal numbers shall be shown on the manufacturers wiring diagram.

e. Electrical connections of supply power, external alarm and control wiring shall be the owner's responsibility.

f. Uninterruptible power supply is to be provided in case of failure of power supply and furnished of 2 hrs. accordingly uninterruptible power supply should be design.

g. Uninterruptible power supply shall prevent the valve closure system from activating in the event AC supply voltage is removed of fluctuates. In the event of a sustained power loss, the valve closure system will activated after a significant power loss and close the container valves.

8. **Operating Air Supply**

a. The system owner shall provide operating air supply, either compressed air.

b. The operating air supply piping shall be 1/2" NPT or of suitable size to accommodate system components.

c. The distance from supplied regulator to pneumatic actuators shall not exceed 10 mtr. nor shall the length of piping for operating gas exceed 10 mtr.

System description

A fail-safe pneumatic isolation system for automatic shutdown drum shut-off shall be linked into the gas detection system. It will turn off chlorine Cylinder isolation valves in chlorine leak condition. Due to which chlorine gas supply will shut off from main source (i.e. chlorine Cylinder). Shut off time of valve should be 4 Sec. Max.

Scope of Work:

Clutch type Air Drive :
a. Qty. as per number of cylinder in service
b. Pneumatic Air operated
c. Enclosure is suitable to chlorine environment
d. Non-Reversible Type

Solenoid Valve

a. Qty. as per number of Cylinders in service

b. Protection : IP 65 Connection suitable to Air line

c. Enclosure/MOC is suitable to chlorine environment

d. Accessories: Necessary Fittings, Pipes, Individual Air Filter with Pressure Gauge for Individual Solenoid valve.

PLC Control Panel

Special functions/ Design criteria required for PLCs

- Laptop based programming unit shall be possible.
- Dynamic mimic generation.
- CPU load not to exceed 50%.
- Memory utilization not to exceed 50%.
- Communication bus bandwidth utilization less than 50%.
- Spare I/Os installed and wired to terminal strip.
- Space and provision in I/O rack and wiring to terminals shall be provided for adding extra 15% of total I/O count
- Power supply distribution by MCB.
- ALL I/O shall be connected through LED indication & fused terminals.
- Communication link between remote I/O and PLCs shall be redundant.

Constructional Features

Totally enclosed, sheet steel clad, dust & vermin proof and floor mounting type with IP 55 degree of enclosure. Only approved make panels of suitable size shall be supplied for PLC and remote I/O panels. The constructional features shall conform to IS:8623 (Part – I) – 1977. Panel front, rear and side door shall be using 1.6 mm thick sheet steel and load bearing members with 2 mm thick sheet steel. Paint shade outside and inside – RAL 7035. Tinned copper earth bus size – 30 x 6 mm. Two Earthing studs shall be provided externally at side of the panel. Front door shall be hinged type with concealed hinges. Door swing shall be 85 to 90 degree. Cable entry shall be from bottom.

Panel shall be free standing type an each panel shall have 4 Nos removable lifting hooks at top. Suitable cable clamping arrangement shall be provided. Cable termination shall be done with pin/U type lugs. Gland plate 3 mm shall be provided. All door and cover plates for cutouts shall be provided with suitable Neoprene/ rubber gaskets to give the required degree of protection. Panel internal wiring shall run through PVC channels with covers. Door shall be provided with locking arrangements. 4.3.22 Tolerance shall be +5 mm of panel dimension. All cubicles, racks and modules to be provided with readily visible identification labels. Necessary 240V AC power supply spike buster to be provided for connection of instruments during maintenance. Copper/ Aluminum bus shall be provided for grounding purposes. All cables shall enter from bottom of panels and removable gland plates will be provided with each cubicle.

Following shall be provided in each vertical panel – 5A, 240V, AC Socket outlet with MCB. Lamps for cubicle illumination rated for 240V 50 Hz AC switched on by door switches. Cooling fans of adequate rating for the ventilation of cubicles. All panel shall be provided with 20% spare terminals shall be provided in each panel. Metallic parts of all components shall be effectively earthed using green coloured insulated copper wire or other approved means. Electrical continuity of the whole enclosure / frame work

shall be maintained even after painting. All hinged doors shall be earthed through flexible earthing braids of copper. Electrical & Electronic earthing shall be separate and marked in panels

a. Local control panel (PLC based)
b. AUTO/MANUAL Selection.
c. Necessary push button, indication lamps and switch gears for protection purpose needs to be consideration.
d. Suitable to plant PLC/DCS communication
e. Emergency push button for quick shut off.
f. Power supply to be provided to PLC and Input – Output through switch mode power supply.
g. Hooter to be provide for Audio alarm in Panel
h. Graphics of all operating equipments to be indicate in HMI of PLC Panel

PNEUMATICALLY OPERATED AUTO SHUT OFF VALVE FOR CHLORINE TONER ROUTE VALVE:

PURPOSE	TO CLOSE CHLORINE TONNER VALVE ON cl2 LEAKAGE
LOCATION	CHLORINE TONNER ON ISOLATION VALVE
VALVE CLOSING TIME	4 SEC.
NO .OF DEVICE	01 NOS. PER TONNER/CYLINDER
OPERATION	PANEL BASED
BATTERY BACK UP	2 HRS.
TYPE	NON REVERSIBLE CLUTCH TYPE NON REVERSIBLE CLUTCH TYPE WITH CONTINOUS ROTATION MOTION TYPE (Note : Pneumatic tools or quarter turn pneumatic actuators or Pneumatic Ratcheting Motion are strictly not allowed)
OPERATING MEDIA	PNEUMATIC AIR
ENVIRONMENT	MOC SHOULD BE SUITABLE TO CHLORINE ENVIRONMENT & ATEX Certified
INBUILD FEATURES	AUTOMATIC CLUTCH FOR OVER TORQUE CONTROL, SENSOR, ADJUSTABLE TORQUE
SAFETY CODE	AS PER UNIFORM FIRE CODE (UFC)
SUPPLY SHOULD BE AS PER DRIVE REF. NO.	LZB22-L-A005-52
MAX POWER (HP) **FREE SPEED** **SPEED AT MAXIMUM POWER** **MAXIMUM TORQUE** **REQUIRED AIR FLOW (CFM)** **REQUIRED AIR PRESSURE**	LZB22-L-A005-52 317 RPM FREE SPEED 340 RPM 14.5 NM 16 6.3 BAR
SOUND STANDARD	ISO15744
VENT TYPE	LUBRICATION FREE
EU DIRECTIVES	2006 / 42 / EC (ANNEXURE-1, CLAUSE 1.1, 1.2) (EXCLUDING 1.2.4.3), 1.3, 1.4, 1.5, 1.6, 1.7))
VIBRATION STANDARD	ISO 28927-2
EC STANDARD	DIN EN ISO 12100-2010

UK STANDARD	BS ENISO12100:2010
UK LEGISLATION	S.I.2008/1597(ANNEXURE 1, CLAUSE 1.1, 1.2 (EXCLUDING 1.2.4.3), 1.3, 1.4,1.5, 1.6, 1.7))
PANEL OPERATION	1) AUTO / MANUAL ON-OFF 2) GAS LEAK INDICATION/ALARM 3) EMERGENCY START FACILITY 4) VALVE OPEN / CLOSE INDICATION 5) AIR PRESSURE LOW
ACCESSORIES	1) COMPRESSOR 2) AIR MOTOR 3) SOLENOID VALVE 4) FILTER REGULATOR COMBINATION - LUBRICATOR 5) CLAMP 6) INTER-CONNECTING PIPING/VALVE 7) HOOTER 8) PLC BAED LOCAL CONTROL PANEL

Note for Pneumatically operated Auto shut off valve for Chlorine Toner :-

(a) Bidder remains to obtain necessary latest authorization from OEM / Manufacturer for the supply of above item in accordance to the approved vendor list.

(b) Please note that Manufacturer / OEM shall have regularly engaged in the supply of above item for a period of at least for last 5 years.

(c) Failure to comply above conditions shall be the cause of rejection

SOLENOID VALVE:

Sr. No	Description	Material of Construction
1.	Purpose	To close Chlorine Tonner valve upon detection of Leakage
2	Location for installation	On each chlorine tonner
3	Type	Non-reversible
4	Protection	IP65
5	Environment	MOC should be suitable to Chlorine Environment
6	Accessories	Necessary fittings, pipes, individual air filter with pressure gauge for individual Solenoid Valve

Tank Mounted Air Compressor

Sr. No	Parameter	Specification	Bidder's offer
1	Purpose	To close Chlorine Tonner valve upon detection of leakage through supply of air through pneumatic air system	
2	Location for installation	AS PER DESIGN REQUIREMENT	

3	Bore and Stroke	AS PER DESIGN REQUIREMENT	
4	Piston Displacement (CFM)	AS PER DESIGN REQUIREMENT	
5	FAD (CFM)	AS PER DESIGN REQUIREMENT	
6	Speed (RPM)	AS PER DESIGN REQUIREMENT	
7	Max Pressure	AS PER DESIGN REQUIREMENT	
8	Type of Drive	AS PER DESIGN REQUIREMENT	
9	Air Receiver Cap.	AS PER DESIGN REQUIREMENT	
10	Motor	AS PER DESIGN REQUIREMENT	
11	Outlet connection	AS PER DESIGN REQUIREMENT	

Above remains to be submitted along with Technical Bid documents on letter head, duly signed and stamped.

SPECIFICATION FOR AUTO CHLORINE ABSORPTION NEUTRALIZATION SYSTEM (CHLORINE SCRUBBER)

System description

The system should operate automatically in case of chlorine leak from container/tonner which should be covered by FRP hood with sensor. In case of chlorine leaking from the container/tonner, the system should automatically start i.e. blowers and pumps should start simultaneously. The pump should deliver NaOH from tank through the top of absorption tower and blower which should suck the leaked chlorine from FRP hood should push this sucked chlorine from bottom of absorption tower. Due to counter current flow of NaOH from top and Chlorine from bottom, chlorine gets neutralized. After neutralizing chlorine, chlorine free air will be vented out in the atmosphere. Vendor has to guarantee that at the outlet of the system chlorine content will not exceed than 0.1PPM.

Packed Column Type Chlorine Gas Scrubber System

Design, preparation of P&ID's and Engineering drawings, procurement of all materials, supply, erection, testing and commissioning of complete auto Chlorine Gas Scrubbing system shall be under the scope of supply. FRP Chlorine Gas Scrubbing system with chlorine gas detectors, auto shut off chlorine tonner valves, etc. is intended such that in the event of Chlorine Leakage, automatically as well as through remote operation, leakage can be controlled.

Requirement:-

- Design of Chlorine Gas Scrubber system – Counter Current flow based packed column scrubber integrated with Chlorine Gas Detectors, PLC and automation.
- Base – 1000 Kg of Chlorine to be disposed of through Scrubber System with the help of counter current flow of Caustic Solution
- Bidder remains to Design scrubber system including requirement of caustic pumps, tank volume, packed tower size, air blowers etc.

The scope includes,

1. Review of existing Chlorination System
2. Supply, Erection, Testing and Commissioning of main components like

a. Scrubber system consisting of Chlorine Gas Absorption tower - Packed Column Type with counter current flow (For total 6 locations as mentioned below)
b. Caustic Solution Storage tank
c. Caustic Re-circulation pump with motor
d. FRP hood frontal type for Flexible hose connection
e. Blower with electric motor
f. All electrical cable for blower, caustic pump motor etc. and Control Panel
g. Instrument cables for various switches
h. Temperature Gauge, Density Indicator, compound gauge, Level Gauges, Level Switches etc.
i. Interconnecting pipe and fittings for pump, drain and overflow
j. All types of Valves (Ball valve, diaphragm for flush line, NRVs etc. 0.5" to 2")
k. Damper valves
l. Hose connectors with flange for flexible hose connections near Chlorine Tonner
m. Control panel cum PLC (PLC If applicable) with interconnecting wiring for necessary automation, remote etc. integrating of existing electrical control panel
n. Pressure gauge for Caustic Re-circulation pump
o. UPVC ducting pipe line
p. Interconnecting instrument cable
q. Industrial hooters
r. Auto/manual starting of entire system
s. Civil foundation for blower, caustic pump, Scrubber unit etc.
t. Cabling for control room and indicators for Control Room of water treatment plant / intake well

Scope of Work

The scope includes complete neutralizing system including all following main components but not limited to the same and other equipment necessary to make it fully functional as per the requirement and for safety purpose:-

- Suitable FRP hoods/covers for chlorine tonners with 900kgs of chlorine gas in each tonner,
- Combined ducting with blowers of suitable rating for evacuation of chlorine gas from any tonner
- FRP scrubber unit, caustic solution circulation system with piping valves,
- Alkali circulation Pumps,
- Sensors/detectors for leakage of chlorine gas,
- Auto/manual starting of the above system,
- Electrical control panel

The scope of supply indicated above is a minimum quantity requirement. Any material quantity/service requirement for completing the job in totality will be in bidder's scope.

The broad requirement for major components shall be as under:

A. Split type FRP hoods for Chlorine tonners

a) As per number of tonners in service & storage
b) Thickness 5mm(minimum),

c) Suitable sizing nozzles, as per system design including connection to main header
d) Sliding Window for tube connection and operation,

B. Caustic Storage Tank

a) Fluid handled capacity is 20%w/w caustic solution at operating temperature 80 deg C
b) MOC is FRP + PP OR PPH , Thickness as per system design
c) Vertical cylindrical with flat bottom Type Design,
d) Capacity of tank is adequate for absorption of chlorine leaked from no of completely filled chlorine tonners in service + 20% margin, 300 mm Free Board.

C. Scrubber Column

a) Fluid handled capacity is 20%w/w (maximum) caustic solution and chlorine gas.
b) MOC is FRP + PP OR PPH, Thickness as per system design
c) Vertical cylindrical packed column type
d) Capacity is Adequate for absorption of chlorine leaked from no of completely filled chlorine tonners in service in one hour (maximum),

D. Centrifugal Blower

- 2 Nos. (1W + 1S) suitable to handle Chlorine gas from chlorine tonner and capacity suitable to suck chlorine gas leaked from no. of completely filled chlorine tonners in service in one hour (maximum),
- Body and impeller MOC is MS+FRP
- Shaft MOC is EN-8
- Necessary Accessories like Common base frame, suction filter, discharge damper, belt guard etc.

E. Circulation Pump

- 2 Nos. (1W + 1S), suitable to handle 20% Caustic Solution and of capacity to neutralize chlorine gas leaked from no. of completely filled chlorine tonners in service in one hour (maximum),
- Body and impeller MOC is PP
- Shaft MOC is EN-8
- Horizontal Centrifugal Type
- Necessary Accessories like Common base frame, Valves, Coupling Guard etc.

F. Connection Piping & Valves,

- Duct Line MOC is uPVC (Sch.40),
- Caustic Line MOC is uPVC (Sch.40)
- Valve, Strainer, NRVs MOC is PP.

G. Instruments

All Necessary instruments to be considered by Bidders as mentioned below:

- Level Switches
- Level Indicators
- Temperature Indication
- Chlorine Leak Detectors (3 Nos., One at Chlorination room and Two at tonner room / storage area or as specified in BOQ / tender specs)

H. Electrical Panel / Relay based Control Panel

- Required electrical panel with starters for all equipment meeting tender specs (refer electrical specs)
- Local control panel (Relay based) for automatic operation of Blowers, Circulation pumps, etc. and for instruments monitoring, etc.
- AUTO/MANUAL Selection
- Necessary Push Button, Indication lamps, etc. shall be provided
- Suitable potential free contacts shall be provided for remote monitoring and alarm for PLC/SCADA system (to be hooked up with PLC/SCADA system at central control room)

8.19 Disc Filter

The disc filters shall be gravity fed and should be capable of filtering effluent from secondary clarifiers and achieve the desired filtered water quality as follows.

Design inlet TSS, ppm : 20 ppm
Design Inlet TSS loading factor : 1.5
Design outlet TSS, ppm : < /= 10 ppm
Total backwash water required : Shall not exceed 5% of the design influent flow.
Ancillary Equipment : Portable automatic chemical cleaning unit.

The filters should be sized for peak flow.

Disc Filter assembly with Filter Cloth:

Disc filter shall comprise multiple high strength and separable discs (proposed by manufacturer). Each Disc shall be subdivided into smaller sections to constitute a prefab disc frame (module) so as to ensure easy replacement and maintenance. Each disc consists of minimum twenty (20) separable filter panels (minimum 10 filter panels on each side). In case of replacement of fiber cloth, the left and right of the fiber cloth shall be replaced quickly without disassembling of segments (Disc frames). Each disc shall be mounted on the center drum by strap band (steel band) for the exact roundness and it shall not be fixed by Stud bolts. The additional sealing material shall not be needed for assembling of filter cloth to segment and the fiber cloth itself shall be acted as the sealing material.

Filter cloth shall envelop some parts of backside of filter frame and the several springs shall be used to fix the filter cloth. The drum shall be round type and shall have the enough area in order to discharge the treated water without trouble. The material of the filter cloth shall be polyester; the filter frame that fixes the filter cloth, the disc frame and the segment cover shall be ABS resin. Central drum shall be SS304. Maximum Filtration rate shall be 10 m3/m2/hr. Nominal pore size of filter cloth shall be approx. 10 micron. There should be no separate pump room to accommodate suction cleaning pumps.

Suitable no. of units shall be provided. Raw water shall flow into the respective Disc filter by gravity. Maximum operating head loss across the disc assembly shall not be more than 250 mm. The structure shall ensure that Suspended Solids (SS) are filtered (treated) from outside to inside of the filter cloth installed on both sides of the disc filter, and that filtered water is discharged through the center drum to the treated waterway.

Sr No	TECHNICAL DATA OF FILTER	
1.	Type of Disc filter	Fully submerged outside to inside type
2.	Type of filter cloth	Pile cloth with ABS frame
3.	MOC of filter cloth	Polyester
4.	Nominal pore size, (microns)	Approx. 10
5.	Maximum Filtration rate (m3/m2/hr)	10
6.	Total reject and backwash %	< 3
7.	Backwash System	Automatic Backwash system based on time and level
8.	Head loss across the disc assembly (mm)	250
9.	Thickness of drum	4 mm. (minimum)
10.	MOC of Center drum	SS 304
11.	Filtration mode	Continuous

Drive Assembly:

Drive part of Disc filter shall be of Worm geared type with motor chain drive. The drive comprises Drive Motor, Reduction Gears, Chain and Sprocket. Power shall be transmitted by the SS 304 chain. The reduction gear shall be installed on the base for access for the tension adjustment. A protective cover made of SS304 shall be equipped for the drive motor, reduction gear and the chain. The rpm of the disc filter drive shall be adjustable by the inverter that is attached in the field control panel.

Sr No	Drive Data	
1.	Motor Specifications	Class F / IP 55
2.	Gear Box Specifications	Worm Gear, suitable ratio
3.	Sprocket Drive Specifications	Worm geared motor Chain drive type
4.	Motor Protection	IP 55
5.	Material of Construction - Reduction Gear	Cast Iron FG 200
6.	Material of Construction - Motor	Aluminium
7.	Material of Construction - Chain & Sprocket	SS 304
8.	Rotation speed of filter disc & center drum	< 2 rpm

Backwash system:

Cleaning device consists of Suction cleaning unit, which conducts the suction cleaning on each side of disc with the suction cleaning pump. Cleaning device shall clean the contaminated filter cloth thoroughly by the suction unit on both side of disc along with suction cleaning pump which shall be activated by the water level switch that contacts the water level raised with the increase of the loss of head. Disc filter should be operated for filtration without the stop during backwash and suction of sludge. Suction cleaning unit shall be made of or the even cleaning efficiency without dead zone for all area of filter cloth. Suction cleaning pumps shall be of submersible type and shall be directly mounted on the top of Filter unit. One pump shall cater to maximum two discs. Design should be such that suction cleaning pump discharge does not require any valves on the suction side to ensure efficient cleaning of filter cloth.

Sr No	Suction Cleaning Pump Details	
1.	Pump Type	Submersible Vortex type
2.	Motor RPM	≤ 3000

3.	Type of Sealing	Mechanical Seal
4.	Class / Protection	Class F / IP 68
5.	Power Supply	415V x 3 ¢ × 50Hz
	Material Of Construction Suction Cleaning Pump	
1.	Casing	Cast Iron IS 210 FG260
2.	Impeller	CF8M
3.	Shaft	Chrome Steel

Control panel & Instruments

Control panel shall be SS304, double door (Inner & outer door), IP55, self- standing, floor-mounted type in case if it is outdoor. Indoor control panels shall be CRCA, powder coated and self- standing, floor-mounted type. Control panel shall contain PLC, HMI (6", colour, touch screen), circuit breaker, relay, terminal blocks, push button switch, indication lamp, etc. on the door. Control panel shall accommodate an inverter/VFD to control the rotation velocity of the disc drive. Automatic/Manual switch and indication lamp shall be equipped in case of breakdown of the automatic interlocking device. Control panel shall have a nameplate displaying the name of the equipment; operation switch shall have a nameplate indicating its intended use.

Sr No	Accessories	
1.	Control Panel Type	Self- standing type, Floor mounted Outdoor – Double door Indoor – Single door
2.	Control Panel MOC	Outdoor – SS304 Indoor – CRCA, powder coated
3.	Control Panel Protection	Outdoor – IP55
4.	Level Switch / Transmitter Quantity	Min 1 per stream
5.	Level Switch / Transmitter Type	Conductivity level switch / Hydrostatic level Transmitter
6.	Valve Quantity	1 Lot

Spare Media: The contractor shall maintain minimum 5% spare cloth media against the total media requirement for each filter unit shall be maintained as spare for each equipment.

Bidder shall provide disc filter based on above specification and in case of any minor changes in above specification based on OEM requirement then proper justification/documentation shall be provided for approval.

8.20 Submerged Ultrafiltration System

Bidder shall provide submerged Ultra filtration which is a type of membrane filtration in which hydrostatic pressure forces a liquid against a semi permeable membrane. A semi permeable membrane is a thin layer of material capable of separating substances when a driving force is applied across the membrane. Ultra filtration is aimed for removal of bacteria and other microorganisms, particulate material, colloidal matters, colloidal Silica, and natural organic material, which can impart color, tastes, and odors to the water. The characteristics of filtered water from Ultra filtration shall be guaranteed by bidder as per tender.

The UF membrane shall be designed for flow and specifications given in the tender document. Bidder must tie-up with a Technology Provider for Tertiary Treatment Plant (TTP) based on submerged UF.

Submerged Ultra filtration shall consist of hollow fibers membrane material which shall be installed in RCC / prefabricated open tanks or cells. The feed water flows either inside the cells / tanks and through lumen of the fibers. Suspended solids and solutes of high molecular weight shall be retained, while water and low molecular weight solutes shall pass through the membrane.

Submerged Ultra filtration system shall consists of the following:

- UF Feed Sump and pumps (if required). Alternatively, the feed water after chlorination shall flow by gravity into the cells depending upon system design.
- Pres-Screening in the form of Automatic Self-Cleaning Basket strainer, in case of pumped flow.
- Pre- screening in the form of rotating drum screens with automatic operation, in case of gravity flow.
- Submerged Ultra-filtration Cells / Tanks fitted with membranes modules
- Filtrate Transfer pumps for withdrawal of filtrate
- Chemical dosing system along with necessary dosing tank, pumps, accessories and Online static mixer
- Air Scour blower for backwash
- Filtrate Backwash Pump for backwash
- UF CIP and MW system
- Disposal of UF Backwash waste and Neutralized Waste
- Any other units, as required to complete the system

1. UF Feed Sump & Pumps (If required)

UF feed sump shall receive the secondary treated effluent/treated sewage from the upstream units. Function of this sump is to hold the incoming feed water so that it shall be pumped to the downstream UF system. UF Feed sump shall consist of sluice gates on upstream for flow regulation and system bypass. The sluice gates shall be installed such that it is possible to operate them manually, inspection as well as operation by standing on a platform constructed at a suitable elevation adjoining the UF Feed Sump. The UF Feed Sump shall be of adequate size to meet the requirements of workability inside it. The sump shall be open to sky / covered and shall be water tight to prevent seepage of the water. The entire construction is in M30 grade concrete and as per IS 3370. RCC access platform minimum 1000 mm wide with railing as per specifications shall be provided on one side of the Feed Sump. Ultrasonic Non-Contact type Level Transmitter shall be installed for pump auto-operation.

Pumping machinery shall be designed based on incoming flow. The pumps shall be Submersible Clear water pumps with centrifugal, non-clog type design. The speed of pump shall not be more than 1500 rpm. The impeller should be of a non-clog design with smooth passage and solid handling capability of 40 mm size.

The pumps shall have automatic coupling arrangement at discharge end for removal and a guide pipe and chain in SS 304 will be provided for removal and lowering of pumps. Pump shall run smooth without undue noise and vibration. Vibration shall be limited as per BS 4675 Part I.

The motor shall be squirrel cage type, suitable for three phase supply continuous duty with class ‘F’ insulation. Motor shall have integral cable parts and the cable entries shall be Sealed. Complete rotor shall be balanced dynamically.

Design Flow	:	As per tender
Minimum Retention Time	:	As per UF System Down Time or 10 min at design flow
Min. No. of Pumps	:	1 Working + 1 Standby
Type of Pumps	:	Submersible type non-clog design
Solid passage size	:	40 mm max. Through Pumps
Insulation	:	Class F
Protection	:	P-68
Specific gravity	:	1.05
Temperature	:	Min. 20° C
Efficiency	:	more than 70%
Installation	:	Fixed.
Casing	:	Cast Iron IS 210 Gr. FG 260
Impeller	:	SS304
Shaft	:	AISI 410
Cable gland	:	Cast Iron IS 210 Gr. FG 260
Motor Body	:	Cast Iron IS 210 Gr. FG 260
Sealed cover	:	Cast Iron IS 210 Gr. FG 260
Automatic Coupling	:	CI
Duck foot bend	:	CI
Guide Pipe	:	SS 304
Lifting chain	:	SS 304
Fasteners	:	MS with GI coating

Electrical panel of the Pumps shall be placed in such a manner to avoid corrosion from gases.

Electrical Hoist - comprising of I-Girder and a 2 ton or more chain pulley (the chain pulley block capacity to be 2 Ton or 1.5 times the maximum single unit/ weight that may be required to be removed for maintenance) with horizontal travel on the I-beam shall be provided for removing the UF Feed Pumps.

2. Basket Strainers/Filter (For pumped flow)(If required)

Min one Number of automatic self-cleaning type basket filter / strainer shall be provided at common header of UF Feed Pumps. The screening media shall have max. 1000 micron opening / perforation size. Associated equipment and arrangement necessary for automatic cleaning and discharge of screenings shall be provided.

The automatic self-cleaning pressurized strainers (with manual override facility) for each Ultra Filtration unit shall be:

- Fitted with media containing 1000 micron (max. opening / perforation) multi-layer weave type or such suitable / equivalent screen and shall remove screenings which are greater than 1000 micron in size in any dimension.
- Capable of filtering the maximum flows of secondary treated Sewage as per design flow.
- A proven design for effective removal of debris from Sewage flows.
- Capable of operation for long periods without attention under all flow conditions.
- Operate and clean automatically and shall be with manual override facility.
- Controlled by ‘pressure differential’ and by ‘timer’ in automatic mode by plant control system. Diff. Pressure Transmitters shall be provided across each strainer for monitoring the clogging / head loss and initiate automatic back wash cycle. When the pre-set differential pressure or time

reaches, self-cleaning shall begin. No interruption of flow during backwash / flushing. Flush valve / Exhaust Valve / Drain Valve for dirty water disposal to operate automatically, to open during cleaning cycle.

- Enable any gases that might accumulate in the housings of the filtration units to be vented safely.
- Shall be self-cleaning i.e. separate backwash water feed shall not be required.
- Each basket filter shall be provided with an inlet and outlet isolation valve as well as a bypass piping with valve.

Design Flow	:	As per tender
No. of Basket Filters/Strainers	:	As per design
Type	:	Max. 1000-micron weave wire type or suitable re-usable filter element, automatic self-cleaning type with manual override facility. Flow Direction: Out to In
MoC	:	SS304 strainer and housing
Max. Working Pressure	:	Suitable upto 10 bar
Min Operating	:	As per design
Head Loss under Normal Operation	:	As per design
Max Head Loss	:	As per design
Cleaning Mechanism	:	Electric self-cleaning mechanism through suction nozzles spiraling across the screen / rotating scrapper mechanism. Filtered water flow to continue during backwash. Pump On & off or flow diversion during backwash of basket filter not permitted.
Backwash Quantity per Day	:	As per design
Control System	:	PLC based operation and backwash / cleaning cycle

3. Rotary Drum Screen (Perforated Type) (For Gravity Flow)(If required)

Depending upon the flow regime and upstream hydraulics, submerged ultrafiltration units shall function on influent gravity function. In such a case, Rotary drum screens shall be provided in pre-screening channels that will receive secondary treated effluent from upstream units. Min. one numbers of Mechanical Rotary Drum Screen (as Working) and one number of Mechanical Rotary Drum Screen (as Standby) shall be provided . Each Screen Channel shall be designed for 100% of Design Flow. Screen channels shall be designed in such a way that, the laminar flow condition shall be maintained in the approach channel of screens. The entire construction shall be in M30 grade reinforced cement concrete and as per IS 3370. RCC Platform / Walkway, minimum 1.20 m wide with Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit and to the Operating Platform/Walkway.

The clear opening of perforations shall be 1 mm for the Rotary Drum Screen. Conveyor Belt and Chute arrangement shall be provided to take the screenings. Screenings dropped from Chute shall be collected in a wheel barrow. Mechanically operated CI Sluice Gates / Valves shall be provided at the upstream and downstream end to regulate the flow.

Design Flow	:	As per tender
Number of Units	:	Min. 1 Mechanical (Working) + 1 Min. Mechanical (Standby) each designed for 100% peak flow
MoC	:	SS304
Approach Velocity	:	> 0.30 m/s

Velocity through Screen	:	Min 0.60 m/s – Max 1.20 m/s
Wheel barrow	:	1 No. min
Max Head Loss across screen	:	Max 0.3 m/s

All other accessories, whether specified or not, but required for meeting the requirements of the contract shall form the part of Bidder‘s Scope.

4. Submerged Ultrafiltration System

The proposed UF system shall be provided with submerged UF membrane system. Submerged UF cell/tank shall be designed for N-1 operation philosophy. The plant output shall not reduce the design flow when one cell/tank is offline during routine maintenance or cleaning. Each cell/tank shall be designed with required membrane installed. The flux selection for the design is discussed in the following table. The system shall be designed for an overall UF recovery of 95% - 97% minimum.
UF cells/tanks shall be constructed in RCC M30 grade reinforced cement concrete and as per IS 3370. RCC Platform/Walkway, minimum 1.20 m wide with Hand Railing as per specifications shall be provided. RCC Staircase, minimum 1.20 m wide with Hand Railing as per specifications shall be provided for access from Finished Ground Level to the top of the Unit & to the Operating Platform/Walkway. Suitable lifting arrangement shall be provided for lifting the racks during maintenance purpose.
The criteria for the design of Membrane Filtration system are given below:

- Daily average suspended solids (SS) in Membrane Filtration Effluent shall be below detectable limit or < 2 mg/L and turbidity shall be < 0.5 NTU at all times
- Fully automatic operation including backwash and cleaning (MW, CIP, etc.)
- Minimize installed footprint and capital/operating cost
- Maximize accessibility and operability/safety

Following equipment shall be included in the Ultra-Filtration System:

- Ultra filtration membrane system will comprise of suitable Ultra Filtration units (all duty), suitable for total UF System permeate flow having min. 95% - 97% recovery.
- There will be an inlet flow control valve/gates for each cell/tank. All inlet and outlet valves for each UF cell shall be pneumatic or suitable actuator operated.
- The entire membrane modules shall be installed in Pre-Fabricated cell/tank or in RCC tank ; which shall be connected to other equipment necessary for the required operation.
- All chemical injecting valve/s to each UF cell for MW / CIP shall also be pneumatic or suitable actuator operated or as recommended by UF vendor for fully automatic operation.
- Complete backwash system including air blowers, pumps and valves shall be provided suitable to perform backwashing of UF cells. The backwash water will be sourced from treated water tank or Filtrate Backwash tank.
- Maintenance Wash (MW) system suitable for periodic chemical cleaning of Ultra Filtration units shall be provided. All chemical tanks shall be designed separately to accommodate a particular chemical (say HCl, NaOH, and Hypochlorite etc.) to be used for all different process cleaning mode. All chemical tanks and dosing system shall be housed in UF building. All chemical dosing / storage tanks shall be provided with overflow and drain line with isolation valve with required piping up to nearby drain, level measuring instrument, etc.
- A Clean -In Place (CIP) system shall be provided common to all units for chemical cleaning of membranes and shall include CIP- clean water transfer tanks, pumps, and all other equipment and auxiliaries to make a complete CIP system.

Instrumentation and Control

- All electrical systems integral to the equipment and necessary for smooth functioning of the complete membrane filtration system shall be provided.
- The instrumentation and control systems including SCADA that shall automatically control the operation of the plant with a minimum of operator intervention shall be provided, with monitoring of water quality at each stage shall be provided.
- Ultra filtration system of each unit shall include a continuous indirect integrity monitoring system. The on-line turbidity meter provided separately for each cell shall measure and record permeate turbidity at least once per minute, which shall be user configurable.

Various components of submerged ultrafiltration system are as follows,

A. Filtrate System: Filtrate from the Submerged UF Unit shall be withdrawn by a filtrate pump controlled by a variable speed drive. Filtrate shall be pumped to the treated water tank.

B. Filtrate Backwash System: Part of the treated water shall be pushed through the membranes for a short time in the reverse direction to flush solids from the membrane filtration modules during Backwash cycle. Filtrate backwash pumps shall be used for this purpose and shall be installed in treated water tank.

C. Compressed Air System: Clean, dry compressed air shall be required for the operation of pneumatically actuated valves and for backwash, integrity testing and draining filtrate from the inside of the Membrane Filtration. Air compressors shall be provided for this purpose.

D. Air Blower System: In the backwash process, low pressure air shall be blown into the Rack and distributed down and into the bottom of each Membrane Filtration Module then released up into the fibre bundle. This is the Aeration step of the backwash sequence. Air blowers shall be used for this part of the backwash process.

E. Chemical dosing system for UF Maintenance Wash (MW) & Clean In Place (CIP System) Chemical Dosing Tanks shall be provided for dosing of chemicals required for MW and CIP cycles. These chemicals shall be dosed in the CIP ring main using dosing pumps. UF permeate shall be used to provide clean water required for the preparation of cleaning solutions and for system rinsing. It shall be collected in CIP- Clean Water Transfer Tank and pumped into CIP ring main using CIP Clean Water Transfer Pump. Acidic waste generated during CIP and MW cycles shall be collected in neutralization pit. Neutralization transfer pumps shall pump this waste water to STP head works for further neutralization.

F. Instrumentation and Control System : Submerged Membrane Filtration Units shall be fitted with pressure, flow, temperature, level sensing and other instruments which are used to monitor operation of each Unit. A Programmable logical Controller (PLC) shall control all the unit operations including those of submerged ultra-filtration units. Spare PLC shall be provided.

G. UF- Backwash Waste Collection : When the filtrate backwash and aeration steps of the backwash sequence takes place, the solids that have been loosened from the Membrane Filtration Modules shall be drained from the Cell and shall be collected in backwash waste tank. This waste shall be pumped to inlet of STP using UF backwash waste transfer pumps.

H. **Neutralization Pit :** CIP and MW rinsing and wash shall generate chemical waste water which shall be collected in neutralization pit. Chemicals shall be dosed in the neutralization pit to neutralize the water, if required or else the waste water shall be then pumped to STP head works using Neutralized Effluent Transfer pumps.

Design Criteria for UF system

Design Flow : As per design

Permeate Flow	:	As per requirement
Hours of Operation	:	24 hours
No of Cells/Tanks	:	As per Membrane Supplier requirement and design for N-1 philosophy
MoC of Cells/tanks	:	RCC with anti-corrosive coating
Liquid Depth	:	<= 5.0 m
Design Average Flux for N condition	:	≤ 45 LMH
Max Flux	:	≤ 51 LMH
Membrane Type	:	Submerged, Hollow Fibre, Out to In
MOC of membrane	:	PVDF (100%)
Other wetted components.	:	SS316, PVC-U, Polyurethane, Polyethylene, Polyamide, EPDM
Nominal pore size of Membrane:		0.04 μmeter
Recovery	:	Min 95 -97 %
CIP pH Range	:	2-11
Feed Temperature (°C)	:	Max 40°C

Filtrate Transfer Pumps

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos. Working per UF Cell/Tank + 1 Standby
Standby		
Type of Pump	:	Hori. Centrifugal
Head	:	As per manufacturer requirement
Drive	:	VFD

Material of Construction

Casing	:	SS316
Impeller	:	SS316
Shaft / Shaft Sleeve	:	SS 431

Filtrate Backwash Pumps

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos. Working + 1 Standby
Type of Pump	:	Hori. Centrifugal /Submersible
Head	:	As per manufacturer requirement
Drive	:	VFD

Material of Construction

Casing	:	CI
Impeller	:	Bronze LG4
Shaft / Shaft Sleeve	:	SS 410

UF Backwash Waste Transfer Pumps

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos. Working + 1 Standby
Type of Pump	:	Submersible
Head	:	As per manufacturer requirement

Material of Construction

Casing	:	CI
Impeller	:	SS304
Shaft / Shaft Sleeve	:	SS 410

UF Backwash Waste Tank

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos

MoC	:	RCC

Neutralized Effluent Transfer Pumps

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos. Working + 1 Standby
Type of Pump	:	Submersible
Head	:	As per manufacturer requirement

Material of Construction

Casing	:	SS316
Impeller	:	SS316
Shaft / Shaft Sleeve	:	SS 431

Neutralization Pit

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos
MoC	:	RCC with anti-corrosive coating

Air Scour Blowers

Capacity	:	As recommended by manufacturer
Quantity	:	1 Nos. Working + 1 Standby
Type	:	Rotary – Twin Lobe
Head	:	As per manufacturer requirement
Drive	:	VFD
MoC	:	CI

Chemicals dosing for CIP and MW modes (Hypochlorite, Caustic, Acid, Coagulant, etc. as applicable) Dosing Tank & Pumps

Detail	**:**	Type / No. of Chemicals to be as recommended by UF Vendor
No. of Dosing Tanks	:	Min 1 Nos. for each chemical
Capacity of each tank	:	As per design requirement to store chemical requirement for one week of chemical cleaning
Solution strength	:	As required for membrane cleaning / as recommended by UF Manufacturer
Material of Construction of Tank	:	HDPE / FRP /LDPE/GRP
No. of Dosing Pump	:	Min. 2 Nos. (1W + 1S) for each chemical / application
Capacity of Dosing Pump	:	As per design
Type of Pump	:	Diaphragm
Pressure	:	As required for membrane cleaning

CIP Clean Water Transfer System

No. of Tanks	:	1 Nos. with heater element
Capacity of each tank	:	As per design requirement
Material of Construction of Tank	:	HDPE / FRP /LDPE/GRP
No. of CIP Clean Waste Transfer Pump	:	2 Nos. (1W + 1S)
Capacity	:	As recommended by manufacturer
Type of Pump	:	Horizontal Centrifugal
Head	:	As per manufacturer requirement

Material of Construction

Casing	:	CI
Impeller	:	SS304
Shaft / Shaft Sleeve	:	SS 410

Besides the above listed chemicals if the Bidder requires an alternate or additional chemical as per UF manufacturer for the effective operation of the plant, then same shall be considered & provided by the Bidder. Bidder shall provide inline static mixers wherever applicable for efficient mixing of chemicals. All the dosing tanks shall be provided with slow speed agitators wherever applicable.
The Contractor shall define the guaranteed membrane element life in the pro-rated membrane warranty. The Contractor is advised that the following criteria shall be used for the purposes of defining membrane module life:

a) Failure to meet the specified filtrate quality criteria;

b) Failure to meet specified integrity test requirements; and,

c) Failure to restore the permeability of the membrane to allow the system to achieve the specified Maintenance clean and Routine clean CIP frequency requirements at the design flow using only the duty membranes.

The Contractor shall provide all details of membrane life and pro-rata warranty life to meet the Technical Particulars required for Equipment Performance Guarantees.

All the parameters specified in the tender for biological outlet and tertiary treated outlet parameters shall be possible to measure in-house within the plant laboratory. The bidder shall provide all laboratory equipments & reagents required for the online analysis.

5. Piping for UF system: Guidelines for MOC

Sr. No.	Service	Type of Flow	MOC
1.	Treated Water/ Chemical Recirculation (Common Piping for UF Filtrate Pump and CIP)	Pressurized	SS316
2.	Treated Water (UF Filtrate Pump Discharge header (not utilized for CIP))	Pressurized	SS304
3.	Treated Water (Filtrate Backwash)	Pressurized	SS304
4.	Service Water/ Clean water for CIP	Gravity / Pressurized	GI “C” Class / HDPE
5.	Chemicals	Gravity / Pressurized	SS304/HDPE/PP/ uPVC/cPVC/ suitable for the chemical to be dosed
6.	Waste Water / UF Backwash Waste	Pressurized /Gravity	CI Class “LA” / DI K-9/HDPE
7.	Air Lines	Pressurized	Nylon/HDPE/GI/MS

8. Valve for UF system: Guide Line

Sr. No.	Service	Type	MOC	End Connection
A	**Sewage / Sludge**			
1.	Gravity / Pressurized	Knife Gate	CI Body & SS 304 Gate & SS 410 Spindle	Flanged/Wafer
2.	Delivery of Pump	Swing Check	CS Body & SS 304	Wafer

			Internals	
3.	Suction & Delivery of Pump	Knife Gate	CI Body & SS 304 Gate & SS 410 Spindle	Flanged/Wafer
B	**Service Water**			
1.	Gravity / Pressurized	Ball	CS Body & SS 304 Internals	Flanged/ Screwed
2.	Delivery of Pump	Swing Check	CS Body & SS 304 Internals	Wafer
3.	Suction & Delivery of Pump	Butterfly	CI Body & SS 304 Internals	Wafer
C	**Air**			
1.	Pressurized	Ball	CS Body & SS 304 Internals	Flanged/ Screwed
2.	Delivery of Blower	Swing Check	CS Body & SS 304 Internals	Wafer
3.	Suction & Delivery of Blower	Butterfly	CI Body & SS 304 Internals	Flanged
D	**Chemicals/ CIP Lines**			
1a	Gravity / Pressurized	Ball	As per Chemical Compatibility Chart	Flanged
1b	Gravity / Pressurized	Diaphragm	As per Chemical Compatibility Chart	Flanged
1c	Gravity / Pressurized	Plug	As per Chemical Compatibility Chart	Flanged
1d	Gravity / Pressurized	Butterfly valve	As per Chemical Compatibility Chart	Wafer

Note: Material of construction for all valves required in the UF system shall be as per good engineering practices , process requirement and UF manufacturer recommendation.

Notwithstanding the above, the Contractor shall submit a Valve Schedule with Tag No., Flow, Size, Type, and Material of Construction, End Connection etc. with detailed P & ID for approval of the Engineer-in-charge prior to any further engineering or procurement/fabrication and installation.

8.21 Sludge Digester and Bio Gas Peripheral Equipment

The sludge digester system shall consist of anaerobic digester, and sludge tank along with gas bell. The sludge digester shall produce bio gas for gas mixing and digester heating boiler, and for power generation in the future. The boiler shall be used to keep heating the sludge digester up to 35 to 40 degree Celsius in sludge digester. The work shall include but not necessarily be limited to the following,

(1) Sludge Inlet valves.
(2) Digested sludge outlet telescope valves
(3) Gas mixing pipe line and its blowers.
(4) Gas pipe line to gas Bell and Gas engine.
(5) Sludge heat exchanger
(6) Scum breaker.
(7) Manholes.
(8) Water sprinkler.

(9) Observation windows. ·
(10) Flame arrester and trapping assembly.
(11) Pressure relief valve with flame arrestor ..
(12) Pressure & vacuum control valves.
(13) Gas filters.
(14) Gas blowers.
(15) Mist separators.
(16) Water trap.
(17) Desulfurization equipment
(18) Hot water boiler unit (boiler, gas blower, fuel supply equipment).
(19) Biagas flare.
(20) Pressure gauger
(21) Digested sludge out let flow meter.
(22) Gate Valves.
(23) Hot water circulation pumps.
(24) Sludge circulation pumps
(25) Sampling pumps
(26) Sampling cocks for Digester tank and Gas Holder

The TWL in the digester shall be 2.0 m below the ring beam as a free board. Hopper bottom capacity is not be considered in effective capacity. Bottom hopper shall have slope of 1 vertical to 4 horizontal. Inner opening size of digestion at top of digestion tank shall be at least 2.0 m dia.

Each digester tank shall be provided with Ductile Iron and SS 316 piping specials, equipmentetc., as per requirement of design. D.I. sludge feeder main with Knife gate valves to individual digester to feed the digester from the top of digester, from the raw sludge pump house shall be provided. Suitable valves control etc shall be provided for controlling the flow to individual digester.

Digestion gas (bio gas) is highly flammable and explosive under normal atmosphere condition, all kind of safety valves such as flame arrester and trapping, other safety devices shall be provided at proper locations to avoid any accident cause of Bio gas leakage or catch fire.

Sludge withdrawal D.I. pipelines shall be minimum of 300 mm diameter. The pipeline shall be provided with necessary valves and fittings as required. The pipeline shall start from the center of the hopper portion. It shall be connected with RCC overflow chamber provided outside and below ring beam level through a telescopic arrangement.

Down take pipe of minimum 300 mm diameter from this chamber shall join the main header line feeding the sludge storage tank. The main header carrying digested sludge to the sludge storage tank shall be of D.I and having minimum of 300mm diameter with suitable valves.
One sluice valve with 'Y' shape tee connection having blank flanges shall also be provided in the sludge withdrawal pipelines for each digester for back pressure application / rodding for opening of chokage etc. The RCC overflow chamber as mentioned above shall have a partition wall, one portion shall be used for sludge withdrawal and second portion for supernatant withdrawal. Necessary bends, valves, fittings etc., shall be provided.

Supernatant withdrawal D.I. pipelines having minimum of 250 mm diameter with ring for adjusting the levels shall terminate into the overflow chamber below the ring beam of the digesters. From this chamber another down-take pipe of minimum 300 mm diameter shall be connected to a common header which leads the supernatant to the upstream distribution chamber of the primary clarifiers. Necessary bends/ specials and valves shall be provided.

In case of emergency, the quantity of supernatant withdrawn from the digesters shall be admitted into the distribution chamber ahead of primary clarifiers by gravity. The supernatant withdrawal shall be done simultaneously with sludge pumping in digesters.

SS 316 gas line of minimum 200 mm diameter with a pressure gauge on the top of digester shall be provided with gas tight/gas leak proof valves of standard make (as per details of E & M specifications). It shall be connected to a common header (SS 316) of minimum 250 mm diameter leading to the gas holder. The SS 3l6 pipelines shall be provided with drip traps at suitable elevation. The drip traps shall be housed in chambers and shall· be provided with suitable disposal arrangements to the nearest drain.

Each digester shall be provided with four leak proof inspection manholes having C.I. covers and observation window of 0.6 m x 0.6 m minimum size suitably located on the dome and those shall be leak proof.

Two manholes openings of 1.2 m diameter each shall be provided in the vertical wall just above the formation level. It shall be provided with C.I puddle pipe and C.I blank flanges.

RCC platform of size 1.5 m x 1.5 m shall be provided at ring beam level, acting as a loading/unloading bay for the machinery. Provision shall also be made for railing around the platform as required. Cat ladders shall be provided to reach upto the platform.

Necessary brick masonry chambers shall be provided for valves on all types of pipeline at the ground level. Chambers shall have precast RCC removable slabs and CI./RCC Steps for going down.

All the pipelines from each digester shall be provided with valves so as to isolate it for withdraw or feeding of sludge or gas l supernatant flow etc. as and when required/ desired. For gas service the valve has to be Butterfly valve and in CF8M construction.

D.I. sampling pipes of suitable diameter along with valves and fittings shall be provided in the vertical wall near T.W.L., middle and bottom with a common header to facilitate the independent withdrawal of sample at each level.

The digesters shall work as constant level tanks. Whenever fresh sludge is added, equal quantity of sludge shall be withdrawn by gravity/pumping to next process.
Digesters shall be tested both hydraulically as well as pneumatically with compressed air to withstand a pressure of 250 mmwc water gauge to ensure no leakage of gas. The parameters and description given above pertains to single stage digestion. If the collaborator's design necessitates two stage digestions the same shall be provided.

In either case, the responsibility shall be that of the contractor/ collaborator to provide a safe design to meet the standards required and percentage of solids concentration as specified.

Permission from directorate (explosives) and Pollution Control Boards for construction of digesters shall be obtained by the contractor and any charges/ modifications required shall be at contractor's cost. Bidders are required to get the necessary approval from concerned agency as per the directions of the Employer.

A common RCC open steps staircase 1.2 m wide shall be provided for two digesters with necessary Loadings and connecting RCC platform at ring beam level to have access to both the digesters. Arrangements shall also be made from the ring beam to go upto the apex of the digesters. Tentative location of digesters is shown in the respective Layout plans for each STP.

8.22 Sludge/Biogas Storage Tank Gasholder Floating Cover

(a) A common RCC open steps staircase 1.2 m wide shall be provided for the Gas Holding tank with necessary Loadings and connecting RCC platform at ring beam level. Arrangements shall also be made from the ring beam to go up to the apex of the Gas holding Tank.

(b) Gasholder floating cover shall be constructed of steel with full epoxy coating.

(c) The design shall incorporate a sealed attic space between a ceiling plate provided below the support truss and a roof plate provided above the support truss such that the structural support elements shall be fully separated and protected from any contact with digester contents.

(d) Spiral guides shall be provided for vertical motion of the cover.

(e) Digestion gas (bio gas) is highly flammable and explosive under normal atmosphere condition, all kind of safety valves such as flame arrester and trapping, other safety devices shall be provided at proper locations to avoid any accident cause of Bio gas leakage or catch fire.

(f) In calculating the effective capacity the volume of dome portion of Bell shall not be considered. Each gas holder shall consist of the following:-

- A circular RCC tank of adequate diameter and height shall be provided with RCC floor partly below ground level.
- In raised position of steel Bell the top water level (TWL) in RCC tank shall be 500 mm above the bottom of the Bell.
- A free board of 500 mm above TWL in RCC tank shall be provided. The RCC tank shall have a walkway all around the tank and a balcony of 1.5 m x 1.5 m with a staircase. A steel bell of circular cylindrical shape for gas storage shall be provided.

(g) The floating gasholder cover shall include but not necessarily be limited to the following;

(1) Gas inlet and an outlet piping and valves.
(2) Emergency shut-off valves with bypass line.
(3) Pressure & vacuum control valves.
(4) Pressure relief valves with flame arrestor.
(5) Flame arrester and trapping assembly.
(6) Pressure relief valves.

(7) Gas level gauges.
(8) Pressure meter.
(9). Maintenance manholes.
(10) Drain.
To supply, these Gas safety devices and equipment. Contactor shall submit these manufacture list and experience record to client to obtain the approval in advance. These manufactures must have ISO 9000 certificate to show client quality guarantee.

(h) There shall be a SS316 gas header coming from digesters to feed the gas holder tank. Provision shall be made by connecting gas holder outlet pipelines· to the Bio-gas cleaning equipment, Engine. All the pipe supports for the gas header and distribution piping has to be in SS316.

(i) Connection from outlet shall also be made to blowers to compress gas. The compressed gas shall be supplied ~o different digesters through header main/branch pipelines (SS316) for mixing of digester content. Adequate number of valves (Butterfly valves and non-return valves in CF8M material) shall be provided as required for control.

(j) Outlet from the gas holders shall have adequate diameter to serve the above requirement.

(k) All the control valves provided for gas holder shall be housed inside chambers at suitable elevation from formation level.

(l) Drip traps shall be provided at suitable elevation on gas lines entering into and coming out from gas holder with suitable disposal arrangement to the nearest drain.

(m) The gas holder shall be provided with RCC or SS 316, open stepped staircase to have access from the formation level up to the top of the gas holder. At the top of the tanks, platforms and balcony with G.I pipe hand railing and C.I. vertical posts one meter high, suitably spaced along the periphery of the tank shall be provided.

(n) The-contractor shall make necessary arrangement for filling the RCC tank for Gas Bell.

(o) The gas holder shall also be provided with PVC sheet fixed on one of the guide girders of the gas holder. The PVC sheet shall have graduations marked to indicate the level of gas holder. An alarm system shall also be provided.

(p) An over flow pipe in the RCC tank at suitable elevation having adequate diameter shall be provided and connected to the nearest drain for disposal.

(q) Permission from Directorate (Explosives) and Pollution Control Board for constructing of gas holder shall be obtained by the contractor. Modifications/ arrangement as suggested shall be made at contractor's cost.

(r) Gas flow meter of reputed make as approved by the client for measuring gas shall be provided and installed n the digester control room.

(s) Provide adequate water flushing arrangement in Gas drain lines, so as to avoid any damage to downstream concrete channels/structures/plant items.

(t) All gas piping in the plant should have incorporated Stainless Steel expansion bellows to take care of thermal expansion and to impart flexibility in the piping.

8.23 Occupational Health and safety Management

In order to prevent the industrial accident, for example a fall accident, physical damage, drowning, toxic chemicals and Gas, dropping, flammable oil and Bio-Gas, which may be occurred during O/M and Construction stage, the contractor shall provide a suitable for safety measures need to be implemented.

Especially the sludge digestive facilities need to be enhancement in the incidental facilities, and monitoring apparatus for carrying out stable generating of the digestive Bio-gas.

Since digestive gas has a highly inflammable, the constructor shall provide a suitable safeguard and its monitoring devices for preventing an outbreak of an explosion accident and a fire.

Moreover, preparation of early firefighting devices is required for emergency action. In the sludge treatment machine building shall be provided a ventilation system and a- gas disclosure detector in order to secure a worker's labor and safety. The inside of the sludge digestive facilities shall be installed a sign of prohibition of smoking and fire and safety. education to the personnel periodically.

8.24 Bio-Gas Cleaning Equipment and Peripheral Equipment

(a) Generated 100% of the raw Bio-Gas shall cleaned by the Desulfurization equipment (H2S Scrubbing) to meet the requirement of gas component for Gas Hot Water Boiler and gas engine so that maintenance cost shall be reduced as well as it ran for a long life operation.

(b) The Scrubber shall be biological type, it can be single/ double stage based on the capacity. Maximum H2S content at inlet condition shall be 1000 to 5000 ppm. Operation shall be automatic through PLC/SCADA with manual override system. And inlet pressure shall be of 200 to 500 mm wc. Outlet Biogas shall have maximum 50 ppm H2S content.

c)The material of construction of Drum, Venturi, Reaction column, Recirculation pumping/Drain line, Gas line and Water line shall be SS 316.

(d) Recirculation Pump shall be of centrifugal type with CF8M material of construction.
(e) Caustic Dosing Pump shall be of Plunger type, Plunger shall be SS316L, Liquid end and Through Bush shall be of SS316 and Gland Packing PTFE.

(f) Biogas Scrubber shall have dehumidifier unit which shall consist of Chiller, SS316 Shell tube type Heat Exchanger, condensing unit, PH Analyzer unit and control Panel. Cleaned bio gas shall send to Hot water boiler or flare with the Gas blower.

The work shall include but not necessarily be limited to the following;
(1) Gas supply line and valves.
(2) · Desulfurization equipment.

(3) Flame arrester and trapping.
(4) Pressure relief valves with flame arrestor.
(5) Moisture trap.
(6) Dehumidifier unit
(7) Caustic Dosing unit
(8) Recirculation Pumps
(9) Sedimentation trap
(10) Gas filter
(11) Gas blower
(12) Drain

(g) To supply all equipment and devices, Contractor shall submit all related technical information such as calculation sheet, gas component analyses and evidence at inlet an outlet at the equipment to obtain client approval in advance.

(h) Contactor shall provide all necessary equipment and operation system essential to meet the requirement of Gas Engine.

(I) Desulfurization Equipment

Highly concentrated H2S chemical substance shall be removed to proper level by sodium hydroxide tower or catalytic action or biological method to protect loss in Gas Engine and boiler efficiency and its break-down due to high corrosive nature of the gas.

The package shall include complete set of mechanical and electrical equipments, instrumentation control and automation required for satisfactory and efficient operation of the Plant.

8.25 Peripheral Equipment and devices for Bio-Gas application

(a) Flame Arrest and Trapping assembly

The flame arrestor shall reduce flame power or temperature by metal mesh, and flame trapping is like spring flap door fixed by fuse, which the door shall be instantly closed when its melt by flame to protect fire. Contractor shall provide the assembled the flame arrestor and trap valves on the Bio gas line and its equipment to prevent any accident.

The flame arrestor and trap assembled valve shall be of suitable size for biogas applicable. It shall be used from primarily sludge digestion to Bio gas engine in pipelines, digestors Gas holder to prevent flash back during explosions. This device shall be installed in horizontal or vertical pipeline and hence it should be bi-directional. Other plant items where these units are to installed are as follows :

- Digestor Tank -at safety unit
- Upstream of Gas engines
- Upstream of Hot water Boiler
- Upstream of Bio-gas scrubber.

The flame arrestor and trapping assembled valves shall be designed such that it results in minimal pressure loss under normal operating condition but ensure maximum safety in the event of explosion the end connection shall be flanged.

It shall be constructed of Stainless steel 304 materials of construction.

(b) Pressure relief valves
The pressure relief valves shall be of suitable size for biogas applicable. It shall be used from primarily sludge digestion to Bio gas engine in pipelines to keep controlling the gas pressure constantly to prevent any unusual pressure condition in the pipe line and digestor. This device shall be installed in vertical installed. It shall be constructed of Body SS 304 Epoxy painted, Valve seat ASTM A II b Gr.304, Weight material ASTM A II b Gr.304 and Body Gasket

(c) Gas filters

The Gas filters shall be of suitable size and mesh for biogas applicable. It shall be used upstream of Bio gas scrubber, engine and gas mixing blowers in pipelines to supply dirt free biogas to protect engines and gas blowers against loss in engine efficiency and its breakdown. These are minimum requirements. This device shall be installed in vertical installation. It shall be constructed of casted Stainless steel ASTM A 276 Gr. CFS materials of construction.

(d)Emergency shut-off valves with bypass line.

The emergency shut-off valves shall be of suitable size and closed automatically when receive signal of abnormal heat temperature and gas pressure, which activated by CO2 compressed power cylinder mounted direct on the valve.

It shall be used in Bio gas holder at inlet and outlet in pipeline, and at the same moment, a bypass gas pipeline shall provide for maintenance work. The valves shall be installed in vertical installation. It shall be constructed of Stainless steel 304 materials of construction.

(e) Moisture Trap

The moisture traps shall be designed and be suitable size to effectively separate out moisture in the biogas to gas cleaning equipment and biogas engine such that moisture free biogas is made available at the outlet of a trap. It shall be constructed of Stainless steel 304 material of construction. It shall be provided with suitable drain connection.

(f) Water Trap

The water traps shall be designed and be suitable size to effectively separate out water in the biogas in pipeline such that water free biogas is made available at the outlet of a trap. It shall be constructed of Stainless steel 304 material of construction. It shall be provided with suitable drain connection.

(g) Sedimentation Traps
The sedimentation traps shall be designed and be suitable size to effectively separate out all sediments in the biogas in pipeline such that sediment free biogas is made available at the outlet of a trap. It shall be

constructed of Stainless steel 304 material of construction. It shall be provided with suitable drain connection with safe drip trap arrangement, so as to avoid unsafe leak of gas.

8.26 Rotary Sliding Vane Biogas Blower

General

Rotary Sliding vane Compressor, prime mover and auxiliary equipment shall be designed for the required duty at the specified operating conditions, and for rapid and easy maintenance.

The Sliding rotary vane compressors consist of cylindrical rotor turning eccentrically in a cylindrical stator of a larger diameter, the result is a free half-moon shaped space. Stratified plastic blades slide freely into the rotor slots. These blades, when the rotor turns, are pressed against the internal face of the stator because of the centrifugal force so forming small cells, the volume of which passes from a maximum to a minimum during the rotation. The suction takes place through ports in the stator and in the area of the increasing volumes, the discharge takes place through ports in the stator and in the area of the decreasing volumes at a given level depending on the foreseen discharge pressure. The noise level shall not exceed 85 dBA at 1.0 meter from the Blower. Blowers shall not run above1000 rpm.

Design Requirement

Blower shall be provided for necessary capacity and rating as required and shall be of positive rotary sliding vane, water cooled, single stage oil free gas compressors. The cylinder shall be cast such that gas and water passage shall be separated by metallic wall and shall not have any gasket separating the two.

The gas blowers shall be designed and works tested complete with blower unit, motor, coupling; MS fabricated rigid base plate, water cooling system, gas and water pipe work, forced oil lubrication system, Rubber Anti-vibration Pad, SS 304 Non-return valve, SS 316 Expansion Bellows at inlet and outlet connection of the blower unit, SS 304 Suction filter with SS 316 filtering Element, SS 316 Cyclonic separators, and all regulating and control equipment as required to provide an adequate and efficient compressed high pressure gas supply. Velocity to be considered for gas piping design shall be in the range of 10-12m/sec. The blowers shall have water seals.

The blowers shall be designed to compress wet and sludge gas comprising methane and CO2 with trace elements including H, N & H2S. The gas shall be assumed to be water saturated.

Gas blower gearbox shall be suitable for continuous running and intermittent starting under maximum load with the resultant high torque and shock loads. The gearbox shall have a service factor of 2

A pressure relief system shall be included to operate on shut off pressure of blowers. This shall consist of actuated bypass and main gas valves which shall operate to dissipate the high pressure in the delivery main to the low-pressure digestion tank.

A temperature sensor shall be installed to give a warning alarm and shut down facility in the event of the pressure relief valve operating.

(1) Mode of Operation

(a) The blower shall operate on a duty/ duty assist basis.

(b) Manual control via start / stop pushbuttons at the control panel with auto switch off in case of temperature bypass or over pressure switch operating.

(c) The blowers are to run on either a timed or continuous control selected by a two position selector switch mounted on the control panel.

(d) When 'continuous' is selected, the blower is to run continuously. Where 'timed' is selected the blower is to run for fixed duration and to be off for fixed duration. The timed cycle shall be controlled. by two adjustable timers (0-60 min) provided for each blower.

(e) Blower is to trip and lock out due to the following but the work shall include but not necessarily be limited : (reset shall be manual)

✓ Electrical overload
✓ Earth fault
✓ Motor over-temperature, monitored by thermistors in each phase
✓ Over-temperature in the compressor gas delivery pipeline
✓ Cooling water over-temperature
✓ Rise in discharge pressure
✓ Vacuum in suction line

(2) Motors

Motors shall be squirrel cage type conforming to IS 325. The power rating shall be at least 125% of maximum power requirement. The other features of motors shall be as follows :

✓ Type of duty: Continuous (SI)
✓Method of starting: Star-Delta
✓Class of insulation: F (Temperature rise limited to class B)
✓Type of enclosure: TEFC and Flame Proof
✓Degree of protection: IP 55

An external rapid measuring system permits an evaluation of the blades wear without opening the machines, so that the blade replacement (average life about 12,000 hours) can be programmed in advance according to individual work needs.

The rotor is supported at both ends by roller bearings and is axially located by an angle ring which maintains the running clearances necessary for high volumetric efficiency.

The efficiency of these machines is high and does not alter in time because the blades' wear is compensated for automatically.

Construction Features

Casing shall be robust and defect free casting, cleaned by sand blasting/shot blasting. Casing shall be steel castings are used, they shall conform to Cast Iron IS 210 Gr. FG260.

The rotor slots shall offer free sliding movement to vanes during operation. Rotor shall be Cast Steel ASTM A 216 WCB. Rotor shall have axial clearance and bottom clearance and mentioned by the supplier for the assembly of the rotor. Type of bearings, their lubrication and the type of fit on the rotor shall also be furnished by the manufacturer.

The motor shall have sufficient starting torque so as to be capable of starting the compressor from a no-load condition and running it up to full speed.

Coupling shall be friction disc coupling type, internal gear type may be used. The coupling shall be so designed that they are dismantled without disturbing the internal components of compressors and motor. Coupling shall be suitable for expansion and any other movement of the shaft.

Gears shall be of suitable design and made generally conforming to IS: 4702-Accuracy requirements for high precision gears.

In case of belt drives, the V-belts shall be according to IS: 2494-Specification for V-belts for industrial purposes. If more than one V-belt is required, a matched set shall be supplied.

Removable guards shall be provided on all movable parts which are likely to be hazardous to operating personnel.

If guards are not removable, for example, fly-wheel guards, access openings (if necessary with covers) shall be provided for access to any part requiring attention or for rotary parts manually.

Stainless Steel Filters shall be located such as to permit easy cleaning. Filter shall be placed as close to compressor as possible. The filtering particle size shall be microns and required efficiency.
For non-lubricated Compressor dry filters shall be furnished.

The cooler shall be of water-cooled type and shall conform to the following requirements.

Inter coolers and after coolers shall be designed on the air side to the design pressure not less than the safety valve set pressure. The design pressure for the water side shall be 3.5 bar minimum. The fouling factor to be used on water side shall be as relevant standard. Shell and tube type of cooler is engaged, the design and construction shall be according to IS: 4503-Specification for shell and tube type heat exchangers.

Cyclonic Separator shall be provided to remove oil and condensate after each air cooler.

The air receiver shall be provided after the final discharge shall be manufactured according to IS : 7938-Specification for air receivers for compressed air installation, Where automatic drain traps are used, these shall be provided with isolating valves to allow trap maintenance with the compressor running.

The pipe work shall be of flange end connection confirming to BS EN 1092-1, required with the compressor consists of:

a) Air piping - Inlet and final discharge piping, and

b) Auxiliary pipe work-Lubricating oil, cooling water drain and vent, and instrument air piping. Auxiliary pipe work, required for lubricating oil, cooling water drain and vent and instrument air shall be machine mounted in fully erected and fabricated condition by the manufacturer. The water pipe work shall be fitted with high point vent and low pipe drain connection such that the entire system can be vented and drained.

Controls and Instrumentation
The following instruments shall be included in supply which is considered as minimum requirement. Extra instruments as specified by the purchaser shall also be included.

Pressure and temperature gauges, flow and level indications.

a) Air side -Outlet pressure gauge - each stage

- Outlet temperature gauge -final stage

b) Oil side - Oil level indicator - oil pressure gauge

c) Cooling water side-Cylinder jacket flow indicator for each parallel circuit.

-Temperature gauge at cooling water outlet
- Flowmeter for cooling water

Safety Devices -A suitable safety devices shall be provided to safeguard against high discharge air temperature.

Safety Valves- Final stage only shall be protected by a safety valve. The valve shall be sized for full capacity of the compressor with set pressure not more than 10 percent of the maximum operating pressure of the stage. The safety valve shall be mounted in such a manner that the setting is not disturbed by the vibration.

8.27 Digester heating system

8.27.1 Hot Water Boiler

(a) **Codes and Standards**

The design, materials, construction, manufacture, inspection, testing and performance of boilers and accessories shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal, or superior to the listed standards. Nothing in this specification shall be construed to relieve the Contractor of this responsibility.

The materials, design, construction and testing of the boilers and accessories shall be in conformity with the applicable sections of the latest edition of the Indian Boiler Regulations (if applicable) and all

amendments thereof. It shall be the Contractor's responsibility to satisfy the Indian Boiler Authorities that all the stipulations of these regulations have been met, before fabrication of the boilers and accessories are started.

(b) **Construction Features**

The hot water boiler shall be fire tube vacuum evaporate type

Boiler Supporting Base

The complete boiler including all auxiliaries and accessories shall be shop assembled and shall be supported on a welded steel structural base, which shall form a part of the unit and require only a flat reinforced concrete foundation. Suitable lifting lugs shall be provided on the unit to facilitate handling. Foundation bolts for fixing the steel structural base on to the foundations shall also be supplied.

Platforms and Ladders

The boiler shall be provided with suitable platforms and ladders for gaining access to boiler top for operation and maintenance of valves, for reaching instruments and manholes etc. Platforms and ladders shall be provided with suitable hand railings.

Piping, Valves, Specialties and Instruments

All necessary piping, valves, specialties and instruments shall be in line with enclosed Piping and Instrumentation (P&I) diagram, piping material specifications and as required for safe, reliable and satisfactory operation and proper maintenance of the boiler. Layout of integral piping for boilers shall ensure that all valves, instruments and specialties are located at maximum 1.5 M height as to be conveniently accessible for operation and maintenance.

(c) **Boiler Controls-Oil/Gas Firing**

Combustion Control

The combustion system shall be fully automatic, either modulating type or HIGH/LOW/OFF firing type, with a minimum turndown ratio of 4:1. In either type of control, the boiler shall be ON/OFF control, below 25% of the boiler load. The fuel input to the furnace shall be regulated from boiler hot water outlet temperature using temperature controller or temperature switches and Forced Draft (FD) fan discharge damper or burner· register damper which shall also be simultaneously regulated directly from fuel oil/gas control valve position so as to maintain correct air fuel ratio. Provision shall be made for locking the control at base load. A bypass selector switch shall be provided for manual control in emergency. The combustion control system shall be furnished complete with all actuating and operating devices, necessary control and bypass switches, relays, timers, solenoids and other control hardware.

Boiler Feed Water Control

Feed water supply to the boiler shell shall be automatically controlled to maintain flow at all loads.

Expansion Vessel

For closed circuit hot water system or where the system is pressurized, an expansion vessel shall be provided which shall act as system surge suppresser and main venting point of the system. The expansion vessel shall be installed at the highest point in the system and connected to the suction side of the pumps. The vessel shall be fitted with a sight glass to cover the full operating range and level switches for alarm and interlock for high and low levels. If the system requires to be kept pressurized from NPSH consideration of boiler feed water pumps, nitrogen under pressure shall be supplied to the expansion vessel through control valves to maintain the desired pressure. Safety relief valves shall be provided in expansion vessel to prevent against nitrogen pressure increase above the maximum operating pressure due to any malfunctioning of the system.

A mixing tank shall be provided as per process requirement

(d) **Boiler Safety System**

To protect the boiler from possible damage due to unsafe boiler operating conditions, the fuel feed to the burner shall be instantly cut-off on occurrence of such unsafe operating conditions. The following conditions are considered unsafe for boiler operation:

(a) Burner flame failure
(b) Fuel oil/gas pressure low
(c) Fuel oil/gas temperature low
(d) Feed water supply failure
(e) Hot water temperature high
(f) Failure of FD fan/motor
(g) Water level low in-expansion vessel

For proving the burner flame, burner wind box shall be provided with a suitably located, reliable and fool-proof flame sensor of photo-resistance type.

The boiler safety system shall be complete with all sensing devices such as flame sensor, pressure switches, temperature switches, level switches, all relays, timers, auxiliary switches and other hardware etc.

An alarm shall also be provided to alert the operator on ·occurrence of burner lockout. Also, indicating lamps to indicate each of the above causes of burner lockout shall be provided on the boiler control panel. A push button on boiler control panel for manually shutting off the boiler in emergency shall also be provided.

For gas firing, dual automatic safety shut-off valves in main burner gas line with vent valve on the line between the shut-off valves shall be provided. The discharge of vent valve shall be piped to an area outdoors to a height above building roof where the gas may be safely dispersed.

Also Gas leak detectors (2 nos. per Boiler) shall be provided as a part of built-in safety feature for the Hot water Boilers.

Also utmost care shall be taken on the feed water quality system and necessary water treatment comprising water softener / DM plant shall be in place to feed quality feed water and to safeguard the Boiler tubes from corrosion and scaling effects.

(e) **Programming Control**

A programming control system shall be provided for safe and automatic starting, stopping and emergency shut-down of the boiler. The programming control system shall on start-up, initiate FD fan, purge the furnace and gas passes for a set period prior to the initiation of burner lighting up, initiate lighting up only if all the pre-conditions such as fuel oil pressure "normal" and fuel oil temperature "normal" are satisfied, initiate lighting up of the pilot torch if adequate gas pressure exists, automatically light up the pilot torch and then light-up the main burner. The system shall automatically shut down the boiler on the occurrence of unsafe operating conditions as described above. The system provided shall be complete with necessary hardware.

(f)Boiler Control Panel

The control gear and starting gear for all auxiliaries shall be furnished by the CONTRACTOR and shall be centrally located on a control panel on the steel structural base. In addition, indicating lamps for indicating availability of supply, voltage, indicating operating conditions of each auxiliaries, indicating burner lockout causes shall also be provided on the boiler control panel. The panel shall be factory piped and wired and completely enclosed with access door for maintenance. Motor starters shall be direct-on-line type.

(g)Painting

Two coats of primer shall be applied to all steel and iron surfaces. In addition, finish paint shall be applied to exposed surfaces, as required, to prevent corrosion.

8.27.2 Digestion sludge Heat Exchanger

Concentrated sludge from thickener in digestion tank shall be warm up by hot water supplied from the Heat recovery equipment. At the same time, the sludge in the digestion tank shall be fed to the heat exchanger by the sludge circulation pumps. All components of the Heat Exchanger that come in contact with the sludge and water shall be of stainless steel SA 312 TP 316 Seamless (SS316-schedule 40) construction including the end connection flanges, fasteners, Clamping, U-bolts, Supporting frame structure shall be of SS 316. Only Base Frame shall be of MS Galvanized. The outer pipe shall have Hot Water and Inner pipe shall have Digester sludge which needs to be heated. Temperature of Hot Water at inlet shall be minimum of 80 degree C and outlet shall be minimum 70 degree C. Sludge at inlet shall be upto 35 degree C, and outlet shall be upto 43 degree C.

The work shall include but not necessarily be limited to the following;

(1) Hot water-sludge heat exchanger.
(2) Sludge and hot water circulation pumps
(3) Sludge temperature monitoring system.

(4) Safety valve and Devices.

8.27.3 Digester Mixing Equipment

Gas Mixing and Scum Breaker Equipment

(a) Direct gas insert pipes, lances (SS316L-schedule 40) or Draft tube SS 316L shall be installed at top of digestion tank Digestion tank to mixing sludge effectively.

(b) The mixing of digester contents shall be done by injecting compressed gas drawn from the gas holder. The gas flow shall be 0.3 Nm3/m3 Digester/hr.

(c) The mixing gas shall be supplied from Gas bell pipe line through gas blowers.

(d) Scum breaker and antifoaming water sprinkling shall provide to eliminate forming scum layer on the surface of sludge digestion tank or scum will be loss digestion system as well as it may be to creative obstruction of gas pipeline.

The work shall include but not necessarily be limited to the following;

(1) Gas supply line and valves.
(2) Pressure relief valves with flame arrestor.
(3) Flame arrester and trapping assembly.
(4) Gas filter.
(5) Water trap.
(6) Gas flow meter
(7) Pressure meter.
(8) Pressure switch for gas - low/high pressure indication
(9) Mist separators
(10) Gas compressors.
(11) Water sprinkler
(12) Scum breaker

8.27.4 Electrical equipment

The work shall include but not necessarily be limited to the following;

(1) Control and power part (control system)
(2) Circuit breaker
(3) Power switches and measuring units
(4) Modular control system
(5) Power part (circuit breaker, power switches)

8.27.5 Room for Boiler

(a) Boiler shall be coupled and mounted on steel base frame.

(b) Gas leakage detectors shall provide in the Boiler room along with alarm annunciation.

(c) Requirement for Boiler room floor: Dust free concrete or pavement

(d) Ventilation of Boiler room:
Boiler room should be well ventilated by forced ventilators with minimum ten times per hour air change rate.

(e) Minimal air change quantity technically required corresponds to the heat lost from cogeneration unit and inlet air to be burned by boiler.

(f) Other safety requirements for air change shall be solved according to locally valid safety rules and standards to the satisfaction of Engineer.

(g) Oil tank shall be located on the cantilever on the wall in the boiler room.

(h) The electrical switchboard with base frame shall be located in adjacent to boiler.

(i) Venting (degassing)
Piping above the roof with min. distance 3 m from possible source of the fire

(j) Exhaust piping

(1) Independent exhaust piping of appropriate sizing leaded over boiler room.
(2) Piping shall be made of stainless steel SS 304.
(3) Leaded into chimney- overpressure system required.
(4) Height of Chimney shall be minimum of 30 m for Boiler with local regulations.

(k) Installation space

(1) Minimal free space from unit base frame on side of the unit 2000 inm (for both side).
(2) Minimal free space in front of electrical switchboard 1500 mm.
(3) Minimal free space from side where piping connection 1500 mm.

8.28 Biogas Flare

The open flare unit shall be designed for biogas flow generated during average flow conditions with continuous duty condition. It shall be fabricated of suitable materials (carbon steel with epoxy coating except for top portion which shall be in SS316 including the wind shield). The design of flare unit will be such that it shall be conveniently mounted on the steel supporting structure. The flare system shall be operating automatically with manual over drive option.

Inlet feed biogas shall have Methane content of 50 to 65%, Carbon dioxide of 25 to 35 %, and only scrubbed biogas shall be fed to flare which is Hydrogen Sulfide (H2S) content with in 50 PPM.

The Modular Flare structure consisting of 11 meters (minimum) Height with line size of minimum 300 mm main gas line shall be of Cast Iron, feed temperature of biogas of 35 to 43 degree temperature with MS epoxy coated structural members, ladder with safeguard, Platform with railing, mounting

arrangement for burner piping, and control panel and riser pipe with necessary isolation valves and check valve. Flare Burner shall be of aspirating type, ignited by pilot Burner with vertical, flange mounted and flame arrester shall be SS 316. Pilot Burner shall be of aspirating type, ignition is automatic and flame sensing shall be by thermocouple. Pilot Burner piping and flame arrester shall be of SS316.

(a) The velocity of biogas through the flare unit should be minimal keeping in mind 100-200 mm Water column pressure of biogas at flare inlet. The design of flare unit should allow maximum possible turndown ratio.

The flare work shall include but not necessarily be limited to the following;

(1) Electric ignition(Automatic) and flame control equipment
(2) Gas burners (Flare Burner with Pilot Burner).
(3) Flame arrester and trapping.
(4) Water/Moisture Trap.
(5) Gas Flow meter.
(6) Gas compressor
(7) Lightening protection.
(8) Motorized CF8M Butterfly valve
(9) Igniter
(10) Pilot Solenoid Valve
(11) HT Electrode (SS 316)
(12) Pilot Temperature control Element, Temperature Indicator controller, Pressure Gauge and Switch and all other related instruments.

(b) A suitable spark ignition system aforesaid should be provided at a convenient location. Biogas /LPG shall be used as a pilot fuel. The pilot flame generated with the help of spark ignition systems shall propagated through the flare unit to ignite main biogas. The control system involving control panel, ignition transformer, etc. shall be provided for the said purpose. Control panel shall have audio-visual alarms for flow monitoring and push button ignition system.

(c) H.T. cable shall be provided from the secondary terminal of ignition transformer upto spark ignition system. Necessary ignition electrode shall also be provided (d) Adequate number of gas burners (minimum 2. Nos. (lW+lS)) shall be provided to burn the biogas with 100% standby. Fencing shall be provided for gas burner area.

(e) The Gas pipe connecting the Flare to the Gas plant must contain the following devices: an isolation device operated manually, an emergency shutdown device which interrupts the biogas feed automatically, a flame trap as a safety device.

8.29 Bio Gas Engine & Heat Recovery System

General

Cleaned Bio gas shall be supplied to Bio gas engine to produce electric power and take advantage of waste energy during running engine by heat recovery system so called "co-generation unit".

The work shall include but not necessarily be limited to the following;

(1) Gas Engine and Generator with Electrical Panel.
(2) Gas supply line and valves.
(3) Pressure relief valves with flame arrestors.
(4) Flame arrester and trapping assembly.
(5) Gas filter.
(6) Water trap.
(7) Gas flow meter
(8) Gas line distributor valves.
(9) Pressure meter.
(10) Pressure switch for gas - low/high pressure indication
(11) Solenoid valve
(12) zero pressure regulator
(13) Drain.
(14) Other necessary items.

8.29.1 Bio Gas Engine

(a) Generated 100% of biogas shall be utilized to run Gas engine and produce electric power by generator. Electrical efficiency of power generation shall be minimum 38 % and at least 90% of utilization rate annually under continuously on duty for about 8,000 hr. Engine voltage level shall be either 415 V or 11 KV based on the bidder design.

(b) Produced electric power shall be supplied to main power line to run the Plant.

(c) Assembled engine and generator shall be operated under the following condition;
(1) The system should be suitable for continuous/ base load operation.
(2) Momentary speed variation shall not exceed at 10% in no time.
(3) Normal speed variation shall be not exceeded at 5 %.
(4) Recovery time shall be within eight seconds.
(5) Location to be operated shall be in Bangalore in India.
(6) The assembly shall be installed in the engine room with heat recovery equipment.

(d) The Assembled Engine shall be manufactured with necessary in-built safety features in comply with relevant applicable Indian/international standard.

(e) Each Engine shall be provided with following components but not limited to the following:

► Engine body with spark ignition system
► Starting system (Batteries)
► Fuel supply system
► Carburetor
► Distributor
► Speed adjusting device (electronic speed Governor), throttle valve
► Ignition system
► Silencer (pollution control device)
► Cooling system

► Lubricating oil system
► Pressure relief and safety valves.
► Pressure gauges, Level gauges
► Rotating meters, Thermometers and Flow meters.
► Air and oil filters and strainers
► Noise protection, and
► Expansion joints, valves. pipe line for gas and water.
► Tools (Special and maintenance with a tool box), firefighting equipment and safety gears (helmets, ear muffs, earplug, safety goggles etc)
► Portable rotating meter, Potable noise meter, Potable vibration gauge, Potable thermometer
► Integral robust fabricated steel base frame with anti-vibration mounting pads.
► Anchor bolts
► Back-up cooling system
- Dry cooler - For emergency cooling
- Three-way valve - To control engine water temperature

(f) Engine Body

(1) Fine finished Liner of cylinders shall. be manufactured with abrasion resistance made by special metal.
(2) Common bed shall provide with shock prevention device and its stoppers.
(3) Total vibration value at common base on duty shall not be exceeded at 0.3mm measured by axial and horizontal direction respectively.
(4) Crankshaft and propeller shaft shall be made by grade AA forged steel.
(5) Combustion system shall provide air filter, gas carburetor and spark plugs, air compressor.
(6) Speed adjusting device shall provide with perceptive action.

(g) Starting system

Engine shall be started by appropriate electrical system. Automatic start and stop program shall be in-built to the Genset.

(h) Method of Power transmission
Bio gas engine shall be linked to ·power generator by flexible joint or hydraulic coupling.

(i) Cooling system
Jacket water system shall be applied and the heat energy will recovered by heat exchangers to heat sludge in the primary sludge digestion tank.

G) Silencer
The silencer and its pollution control device on its exhaust pipe shall provide to meet according to the national standard.

(k) Noise level not to exceed 90 dBA measured at 1.0 meter from the Engine.

(I) Exhaust gas component from engine shall be in complying with the ambient air standard.

(m) Protection devices
Mechanical protection of overload and emergency stop shall provide. Safety covers shall be provided over rotating parts.

(n) Engine management system shall be provided so that if the actual methane number is lower than the specified the knock control shall responds and first the ignition timing shall changed at full rated power, secondly the rated power shall reduced.

(o) Spare parts shall be provided as per the quantities required for the period indicated below, but not limited to ;

Item	Quantity
One year maintenance parts;	2 sets
Spark plugs;	7 years
All kind of filters;	7 years
All kind of Packing:	7 years
Standard spare parts	2 sets
Oil & Grease;	2 years
Tools with Box;	1 set/ engine

8.29.2 Heat Recovery system

(a) Heat recovery system to utilize waste heat from running engine shall provide to heat up 100% of inlet thickened sludge in primary sludge digest at 35 to 43 degree Celsius. Generated gas shall also supply to heat exhaust exchange and gas boiler unit so called "waste heat recovery boiler" as back up system to keep sending hot water to sludge heat exchanger to warm up digestion tank as required in case engine is not service. Flue gas heat exchanger shall be SS 316 material of construction.

(b) Hot water control valves and water temperature meter shall provide to control hot water flow in case of not to use heat exhaust/ heat exchange or heat from gas boiler is required.

(c) It is absolutely necessary to keep monitoring water flow through Digester heating circuit when Engine is in operation since there is danger of exhaust Heat Exchanger severe damage.

The work shall include but not necessarily be limited to the following;

(1) Jacket heat exchanger.
(2) Exhaust heat exchange and gas boiler unit:
(3) Cooling water pumps
(4) Cooling towers
(5) Heating water pumps
(6) Hot water control valves
(7) Hot/Low water tank
(8) Safety valve - heating water circuit

(9) Safety valve - cooling water circuit
(10) Jacket water supply unit
(11) First filling of Genset like lube oil, engine jacket water, anti corrosive agent and Battery acid

8.29.3 Room for Engine/Generator

(a) Engine and generator shall be coupled and mounted on steel base frame with inserted anti vibration elements. Transmission of the vibration shall be minimal. There shall not be any anti-vibration concrete blocks and foundation shall be sufficiently strong to take care of static load.

(b) Gas leakage detectors shall provide in the Engine room along with alarm annunciation.

(c) Requirement for engine room floor: Dust free concrete or pavement

(d) Ventilation of engine room:
Engine room should be well ventilated by forced ventilators with minimum ten times per hour air change rate.

(e) Minimal air change quantity technically required corresponds to the heat lost from cogeneration unit and inlet air to be burned by engine.

(f) Other safety requirements for air change shall be solved according to locally valid safety rules and standards to the satisfaction of Engineer.

(g) Oil tank shall be located on the cantilever on the wall in the engine room.

(h) The electrical switchboard with base frame shall be located in individual room adjacent to Co Generation unit.

(i) Venting (degassing)

Piping above the roof with min. distance 3 m from possible source of the fire.

(j) Exhaust piping

(1) Independent exhaust piping of appropriate sizing leaded over engine room.
(2) Piping shall be made of stainless steel SS 304.
(3) Leaded into chimney- overpressure system required.
(4) Stack Height of Chimney shall be minimum of 30.0 m for Biogas Genset with local regulations.

(k) Monorail with Manual Hoist of suitable capacity shall be provided in the Engine Room to facilitate Installation and maintenance of the Engine.

(I) Installation space
(1) Minimal free space from unit base frame on side of the unit 2000 mm (for both side).
(2) Minimal free space in front of electrical switchboard 1500 mm.

(3) Minimal free space from side where piping connection 1500 mm.

8.30 Plant Drainage Pump set

(a) The total head capacity curve shall be continuously rising towards the shutoff with the highest at shut off.

(b) The pump shall run without undue noise and vibration.

(c) The power rating of the pump motor shall not be less than the power required from zero discharge to zero head.

(d) Pump shall be submersible type with double mechanical seals. Motor shall be of IP 68 protection.

(e) It shall be suitable for handling turbid water. Pump and motor shall have common shaft.

(f) Delivery pipe of drainage pump sets shall be of size 40 NB and as per IS 1239, heavy class. Required length of pipes and fittings shall be provided. Pumping main shall be common for two pumps.

(g) Level switch to start and stop the pump automatically shall be supplied with the pump. A level indicator shall also be provided.

(h) The capacity, total head and range of operating head of drainage pump set shall be as specified in particular mechanical requirements.

(i) The material of construction of pumps shall be as follows:

S. No.	Component	Material
(i)	Impeller	Stainless Steel : ASTM 743CF8M
(ii)	Casing	Cast Iron : IS 210 Gr. FG 200
(iii)	Shaft	Stainless Steel: BS:970 GR 410

8.31 Facility used for domestic water

This facility shall be installed as a daily water supply facility in offices, water quality analysis rooms, etc.

Water supply pipes shall be installed in office water / shower water / toilet / water quality analysis lab water / chemical dissolving water / machinery facility cleaning water / flower bed water.

In addition, a septic tank shall be installed as a wastewater treatment for domestic water used.

1) Install a water meter.
2) Install an underground receiving concrete tank.
3) Water to the elevated tank with a booster pump.
4) Install a septic tank.
5) Return the drainage to the grit chamber.

8.32 Maintenance facility using sewage treated water

The cleaning water necessary for the maintenance of the facility shall be equipped with cleaning facilities that can use sewage treated water in order to conserve tap water.
The main destination of cleaning water is vehicle cleaning / sewage treatment tank / watering.
1) Consider the following items for the construction of cleaning water facilities.

- Measures to ensure hygienic safety for workers
- Measures to prevent corrosion and blockage of facilities
- Measures to prevent misconnection with domestic water
- Measures to prevent erroneous beverages

2) A concrete washing water tank that can use storage and sewage reuse water shall be constructed.
3) Pump for cleaning water supply shall be operated at the necessary time.
4) A facility that is easy to clean shall be constructed.
5) Submersible Pumps with a water level sensor shall be installed in all drainage drain pits provided in all structures.
6) The drainage pumped up shall be discharged in wet well.

8.33 Fire Extinguishers

(a) Portable fire extinguishers are to be provided for all units as per the requirement of Tariff Advisory Committee (TAC) or meeting the requirement of local regulations whichever is more stringent.

(b) All the extinguishers shall be of TAC approved.

8.34 Propeller Exhaust Fan

(a) The fan should comply with IS 2312.

(b) The blades shall be of mild steel and properly balanced so as to avoid noise and vibration.

(c) The blade and blade carriers shall be securely fixed so that they do not loosen in operation. The means provided for securing the fan mounting or fan casing to the wall partition or window shall be such as to provide a secure fixing without damage to the fan or wall.

(d) Suitably designed guards shall be fitted to the inlet and the outlet side to prevent accidental contact. No flammable material shall be used in the construction of fan. Moulded parts, if used, shall be of such materials as to withstand the maximum temperature attained in the adjacent component parts.

(e) The fan shall have protective insulation or be capable of being earthed. A fan with protective insulation may be of all insulated construction or have either double insulation or reinforced insulation. Each fan should be provided with a 10 sq.mm mesh bird screen. The sheet used for the cowl should be 14 G.

8.35 Forced Fresh Air Circulation System

Fresh air circulation system is to be provided for the Raw sewage pump house,Blower room and other buildings for circulation of fresh air to limit increase in temperature and also avoid stale air presence.

The complete system along with all associated required air supply fans, exhaust fans, ducts, grills, galvanized bird screens, hoods and all necessary accessories shall be provided. Suitable arrangements to prevent ingress of rain water into building shall also be provided. The system shall be designed with required air changes and the contractor shall provide detailed calculations to determine the air capacity, static pressure etc. and relevant technical details for the approval of Engineer.

All duct work shall be of high quality approved galvanized sheet steel guaranteed not to crack or peel on bending of fabrication of ducts.

The ducts shall be fabricated from galvanized plain steel sheets conforming to IS: 277-2003. All duct work, sheet metal thickness and fabrication, unless otherwise directed, shall strictly meet requirements as described in IS: 655.

All joints shall be tight and shall be made in the direction of air flow. The ducts shall be reinforced where necessary and must be secured in place so as to avoid vibrations of the duct and its supports.

Volume control dampers shall be of an approved type, lever operated and complete with locking devices which will permit the dampers to be adjusted and locked in any position.

Exhaust fans of appropriate rating shall be provided for pumping stations. The contractor shall submit the fan selection details for approval.

For axial flow fans / propeller fans, speed limitation shall be as follows:

For impeller diameter of up-to 450 mm – maximum speed shall be 1500 rpm.

For impeller diameter above 450 mm – maximum speed shall be 1000 rpm.

Suitable designed guards shall be fitted to the inlet and the outlet sides to prevent accidental contacts. No inflammable material shall be used in the construction of fans. Suitable protective coating shall be provided for all fans in line with our contract requirement.

Drive motors shall be rated at least 15% higher than the power requirement at duty point or 10% higher than the maximum power requirements at the selected speed, whichever is higher. Motor shall be conforming to TEFC, IP 54 protection.
Ventilation fans selection and sizing calculations shall be submitted by the contractor.

8.36 Air-conditioning Equipment

The air conditioning units shall be of split type, with the outdoor condensing unit mounted on the terrace of the room or grouted on external side of the wall with suitable brackets. AC sizing and selection calculations shall be submitted by the contractor.

8.37 Valves

(a) Valves shall be as per internationally recognized standards. Flanges shall be machined on faces and edges. Flanges shall conform to ISO 7005, IS 6392, BS EN 1092-1/ BS 4504.

(b) Valves shall be double flanged type and the faces shall be parallel to each other. The flange face should be at right angles to the valve centre line. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

(c) Valves buried or installed in underground chamber, where access to a hand wheel would be impractical, shall be operated by means of extension spindle and/or keys. Wherever extension spindle is provided, the valve shall also be provided with suitable headstock.

(d) Valve of diameter 450 mm and above shall be provided with lifting eyes and shall have detachable bolted covers for inspection, cleaning and servicing. Valves of 250 mm and above shall be provided with Gear box/Gear operated.

(e) Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

(f) The valve stem, thrust washers, screws, nuts and all other components exposed to the water shall be of a corrosion resistant grade of stainless steel.

(g) Valves shall be free from sharp projections which are likely to catch and hold stringy material.

(h) All the valve shall be of 10 bar rating.

(i) All the valves on the suction and delivery side of the Sewage pumping station shall be of Motorised Knife gate type.

(j) All valves in the plant shall be provided with dismantling joint/Flexible joint/SS bellows for ease dismantling.

(k) All the valves on the suction and delivery side of the Primary Sludge, RAS, Thickened Sludge, Centrifuge feed, Digester sludge and all sewage & sludge handling pumping system and for all sludge application in the plant shall be of Motorised Knife gate type.

(l) All type of the valves 450 mm and above shall be provided with Bypass valve arrangement 10% of main valve size. For swing check valve will be inbuilt type, for other type of valves shall be external arrangement.

(m) 2 sets of ladders shall be provided in the raw sewage pumping station to facilitate access of valves.

(n) Telescopic valves shall be provided in sludge storage tanks for sludge withdrawal purpose.

(o) For all gas service and process air application the valve shall be Butterfly valves in Resilient seated (gas service) and Metal-Metal seated (for process Air service).

(p) Isolation valves shall be provided both upstream and downstream side of the flowmeter and also in the bypass line.

8.37.1 Electric Actuator

(a) All local controls shall be protected by a lockable cover.

(b) Each actuator shall be adequately sized to suit the application and be continuously rated to suit the modulating control required. The gearbox shall be oil or grease filled, and capable of installation in any position. All operating spindles, gears and headstocks shall be provided with adequate points for lubrication.

(c) The valve actuator shall be capable of producing not less than 1½ times the required valve torque and shall be suitable for at least 15 minutes continuous operation.

(d) The actuator starters shall be integrally housed with the actuator in robustly constructed and totally enclosed weatherproof housing. The motor starter shall be capable of starting the motor under the most severe conditions.

(e) The starter housing shall be fitted with contacts and terminals for power supply, remote control and remote positional indication.

(f) Each starter shall be equipped as follows :

(1) 2 No. Three phase magnetically operated line contactors with no-volt release and electrical and mechanical interlock.
(2) 1 No. Three phase thermal cut-out device.
(3) 1 No. Control circuit transformer fully protected by fuses on primary and secondary circuits.
(4) 1 No. Set of “Open”, “Close” and “Stop” buttons.
(5) 1 No. Local- Off-Remote switches with padlocking facilities.
(6) 1 No. Set of torque and limit switches for “Open” and “Close” positions.
(7) 3 No. Sets of auxiliary limit switches in each direction.
(8) Valve position Analog Transmitter (i.e Actuator accept To Read Analog signal from Actuator to PLC and also To Write Analog Signal from PLC to Actuator) & mechanical indicator and handwheel for manual operation.
(9) Reduction gear unit
(10) Trip signals of Thermoswitch, Torque Switch and Thermal Overload Relay shall be provided for Indication and also integrated to PLC.

8.37.2 Butterfly Valve

Butterfly valves shall be of double eccentric and resilient seated type generally as per BS EN 593 and IS 13095.

Butterfly valves shall be suitable for bi-directional pressure testing. The valves shall be of double flanged long type.

The valves shall be electrically/pneumatically/manual operated to suit the process requirement mentioned elsewhere in this tender document. The valve shall be free from induced vibrations. Valve shall be suitable for mounting in any position.

The valve seat shall be of metal to metal seated design for Process Air and Backwash Air application. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

The shaft shall be stainless steel with Bronze or equivalent seal with self-lubricating bearings. Disc pins shall be stainless steel. Rings shall be bi-directional self-adjusting suitable for pressure or vacuum service. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel. Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be of worm and worm wheel design type, totally enclosed, grease filled and weather proof. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N. All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Material of construction of valves shall comply with following requirement:

Item	**PN 10 Valves**
Body	Process and Backwash Air: Ductile (SG) Iron IS 1865 Gr.500/7 Biogas application: SS ASTM A 743 Gr.CF8M
Disc	Process and Backwash Air: Ductile (SG) Iron IS 1865 Gr.500/7 Biogas application: SS ASTM A 743 Gr.CF8M
Shaft	Stainless Steel BS 970 Grade 431 S 29
Body Seat	Stainless Steel ASTM A 276 Gr.316/ CF8M
Disc seat	Stainless Steel ASTM A 276 Gr. Gr.316/ CF8M
Shaft Bearing	Bronze backed with PTFE
Internal Fasteners	Stainless steel AISI 316
External Fasteners	Stainless steel AISI 316

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.

Valves shall be capable of closing against the maximum flow that can occur in system. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the discs by tapered stainless steel cotter pins.

Valves shall be provided with position indicator to show the position of the disc, mounted on the driven shaft end.

Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully open or closed position (i.e. set points).

8.37.3 Sluice Valves

(a) Sluice valve shall generally confirm to IS 14846.

(b) Sluice valves shall be of non-rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage.

(c) Valves of 400mm and above shall be provided with thrust bearing arrangement for ease of operation.

(d) Valves of diameter 400 mm and above shall be provided with enclosed gear arrangement for ease of operation. The operation gear of all valves shall be such that they can be opened and closed by one man against an unbalanced head 15% in excess of the maximum specified rating. Valve and any gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 400 N.

(e) All valves, spindles and hand wheels shall be positioned to give good access for operational personnel.

(f) All the hand wheels shall be arranged to turn in a clockwise direction to close the valve. The direction of rotation for opening and closing of the valve shall be indicated on the hand wheels.

(g) The material of construction of valve shall be as follows :

S. No.	Component	Material
(i)	Body	Ductile (SG) Iron IS 1865 Gr.500/7
(ii)	Doors	Ductile (SG) Iron IS 1865 Gr.500/7 with EPDM rubber encapsulated
iii)	Spindle	Stainless Steel: BS:970 Gr 431
iv)	Bush	Bronze : IS:318 Gr LTB2
(v)	Internal Fasteners	SS 316

8.37.4 Knife Gate Valves

Design & Construction Details:
The Knife gate valves shall be manufactured generally as per the latest AWWA C520-10 standards.

Other constructional features and details of components of the required valves are to be as under:

The valve body should be of ductile iron construction as specified. The valve should be provided with gate made of stainless steel of grade as specified and the gate should have beveled knife edge at the bottom to cut through and easily enter in the solids settled in the bottom and ensure positive shut-off / closure in sewage environment.

The Valve should be designed for sealing in uni-directional flow application.
The valve should be provided with replaceable type flexible sealing arrangement to offer drop tight shut off. The seals should be made of EPDM rubber and should be held in place by an easily removable type seal retainer ring. The seals should be mechanically retained in place in a machined groove on the face of seal retainer ring. The sealing system should be field replaceable at site.

The valve housing should have integral as cast tapered lugs provided for pushing the gate towards the flexible rubber seal only at the verge of closure with a view to avoid seal wear and achieve drop tight shut off. The surface of the gate coming in contact with the seal should be polished & buffed.

The bonneted valves shall have glandless design to avoid repeated tightening / replacement of gland packing. The stuffing "O" ring seal should be pressurized by thrust washer from both the sides and should be pressurized / tighten by thrust retainer nut.
The packings should be of graphited synthetic yarn to reduce the friction and offer higher life. Provision shall be made to enable tighten the gland packing by means of a pusher arrangement to minimize the leakage through the back of the valve. Replacement of gland packings should be possible in installed condition of the valve without there being line pressure.

The spindle should be double start / single threaded and non-rising type for compact & safe operation. Gate opening indicating arrangement should be provided to find out the extent of gate opening /closing. The operation of the valves shall be manual / motorized as specified elsewhere in the tender specification.

In case the valve is to be operated from a far then it shall be provided with joining couplings, extension spindle, spindle guides and mounting pedestal with suitable anchor bolts / anchor fasteners on the platform.

Materials of construction:

Component	**Material**
Body	: Ductile iron to BS 2789 Grade 420/12
Seal Retainer ring	: Stainless steel to ASTM A-351 Grade CF8M
Inlet Seal / Rubber Seals / O rings	: EPDM Rubber
Knife gate	: Stainless Steel ASTM A 240 type 316
Spindle	: Stainless Steel ASTM A 276 type 316
Assembly bolts, nuts and fastener	: Stainless Steel ASTM A 276 type 316
Spindle nut	: Gunmetal / Phosphor Bronze / Brass
Bracket / Adapter plate	: Mild Steel to IS : 2062 grade A, Epoxy Painted
Packing	: Graphited synthetic yarn

8.37.5 Slide Gate Valve

(a) Valve shall be of wafer type with elastomer body sealing arrangement for bi-directional shut-off. The valves shall be designed to allow gland repacking without relieving line pressure.

(b) Body shall be two-piece cast construction bolted together with a mid-flange.

(c) The elastomer body seal shall be held in body such that it is kept away from direct impingement of any particles in the flow medium.

(d) The gate shall be provided with a beveled edge to facilitate positive closure of valve even with contaminated area.

(e) The body internals shall be countered such that settlement of particles in the media.
(f) Purge connection shall be provided optionally for these valves for cleaning the seating area.

(g) The material of construction of valve shall be as follows :

S. No.	Component	Material
(i)	Body	Ductile (SG) Iron IS 1865 Gr.500/7
(ii)	Gate	Stainless Steel: BS:970 Gr. 316
iii)	Stem	Stainless Steel: BS:970 Gr. 316
iv)	Body seal	Stainless Steel : BS:970 Gr. 316
(v)	Hand wheel	Cast Iron: IS: 210 FG Gr. 260

8.37.6 Non Return Valve

(a) Type of Valve:

• For Raw Sewage, Clear water & Sludge Application: Only Swing type non return valve complying to IS 5312 is accepted for the individual delivery line & Common header of the pump. Swing door valves of size 600mm and above shall be of Multidoor type.

• For Process Air Application: Only Flap type non return valve is accepted for the individual delivery line & Common header of the Air Blower.

(b) The valves shall be suitable for mounting on a horizontal pipeline and flow direction shall be clearly embossed on the valve body. Hydraulic passages and doors shall be designed to avoid cavitation.

(c) Valves shall possess high speed closing characteristics and to be designed for minimum slam condition when closing.

(d) Valve of diameter greater than 450 mm shall be provided, in addition to others, supporting feet and jacking screws. Hinge pins / shaft shall preferably be square in section to ensure positive location of flaps and provide for secure fixing.

(e) Maximum pressure drop across the valve shall be 0.4 mwc.

The material of construction of valve shall be as follows:

S. No	Component	Material
1.	Body and Door	Ductile (SG) Iron: IS 1865 Gr.500/7
2.	Body and Door Ring	Stainless Steel : ASTM A743 CF8M
3.	Hinge Pin	Stainless Steel : BS970 431 S29
4.	Bearings Bush	Stainless Steel backed Teflon
5.	Internal Fasteners	SS 316
6.	External Fasteners	SS 316

8.37.7 Telescopic Valves

The telescopic valve shall be a proprietary item of proven design manufactured in cast iron and adjustable to cater for variation in level.

The bell mouth height shall be controlled by a hand wheel operated from top of the chamber.

The bell mouth, pipe work, spindle and headstock shall be robustly constructed with adequate brackets of cast iron.

The bell mouth shall be connected by swept tees to a cast iron sludge outlet pipe of suitable diameter.

Component	Material
Bell Mouth	Cast Iron : IS:210 Gr. FG 260
Piping	Cast Iron : IS:210 Gr. FG 260
Spindle	Stainless Steel Gr. 304
Hand wheel	Cast Iron : IS:210 Gr. FG 260

8.37.8 Diaphragm Valves

Diaphragm valves shall be of the full-bore type to suit the maximum working pressure ratings required. Body ends shall be flanged and drilled to BS EN 1092-1.

Indicators shall be supplied where specified showing both OPEN and CLOSED positions shall be supplied and provisions made for initiating the operation of remote indicator lights in the fully OPEN and CLOSED positions.

Valves used for toxic or hazardous fluids shall be provided with an additional `O' ring seal of nitrite rubber or other approved material.

Diaphragms shall be composed of moulded reinforced, flexible material attached by studs to the compressor. Diaphragm materials shall, where required, be composed of corrosion resistant material.

8.37.9 Isolating Cocks

For isolation of small bore pipe work tapings for instrumentation equipment etc., and for individual component isolation, the cocks shall be stainless steel, 0.25 turn ball or plug valve with the operating handle arranged to indicate the open and closed positions. Where specified, means shall be provided for securing the valve body to a front panel or near surface.

8.37.10 Pressure / Vacuum relief valves

Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurized in excess of a preset maximum allowable pressure. The valves shall be drops tight under no flow conditions. Minimum of 3 nos of these valves of 150mm diameter shall be installed in the plant at digester and downstream piping.

Vacuum relief valves shall be capable of preventing the vacuum pressure to be developed in the system by allowing air entry. The valves shall be drops tight under no flow conditions.

The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valve.

The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weights or from a spring.

Body ends shall be flanged and drilled to BS EN 1092-1.

8.37.11 Adjustable Weir Plates

The adjustable weir plates shall be manufactured from 3 mm thick SS 304 Plates and to the approval of the Employers Representative.

Weir plates shall be complete with fixing nuts, bolts and washers and suitable for a total vertical adjustment of 100 mm through SS304 clamping plates. Fixings shall be designed for ease of accurately leveling the plates, securing the plates, and shall enable the plates to be adjusted during the life of the Works to accommodate differential settlement of the structure.

8.37.12 Eccentric Structure Valve

(a) Valve shall be eccentric structure or horseshoe type disc and body. The valve shall be used for sludge line and flow control.

(b) The valves shall be for a smooth flux of fluid and suitable for fluid contained sludge and impurities at the treatment plant.

(c) The material of construction of valve shall be as follows:

S. No.	Component	Material
(i)	Body	Ductile (SG) Iron: IS 1865 Gr.500/7
(ii)	Disc	Ductile (SG) Iron: IS 1865 Gr.500/7 with rubber lining
(iii)	Stem	Stainless Steel: BS:970 Gr 304

S. No.	Component	Material
(iv)	Hand wheel	Cast Iron : IS:210 Gr FG 260

8.37.13 Air Valves

(a) The air valve must be of the type that incorporates a kinetic and an automatic air release valve in one unit. It should be able to release air (gases) and to admit air into the sewage line, when the line is emptied.

(b) The air valve must guarantee complete separation of liquid sewage from the sealing system of the air valve under all working conditions.

(c) The air valve must have arrangement for draining and flushing by external water.

(d) All sealing mechanism system parts of the air valve should be made of stainless steel-316.

(e) The body of the valve should be such as to minimize the accumulation of sewage deposit at the bottom of the coating or of cast iron. The valve mechanism must be such as to prevent opening of the air valve upon every slight pressure change in line. Air Valve shall be Epoxy powder coating shall be provided inside and outside.

(f) Each air valve must be supplied with a resilient seated sluice vale for isolation for maintenance purpose.

S. No.	Component	Material
(i)	Body & Top Cover	Ductile (SG) Iron: IS 1865 Gr.500/7
(ii)	Float/Balls	SS 316
(iii)	Cover Bolts	Austenitic alloy steel
(iv)	Gaskets & Seals	EPDM

8.38 Domestic Water Pump sets

The Pump shall be of Centrifugal type, self-priming and monoblock type. All the necessary piping with union, bends and tees shall be provided. Suction and discharge isolation valves and non-return valves on the discharge side shall be forged steel. Piping shall be as per IS: 1239 heavy class.

8.39 Approved Vendor/Manufacturer/Make List-Mechanical Equipment

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
1	Air Compressor	M/s Kirloskar Pneumatic
		M/s Atlas Copco
2	Air Blowers (Roots Type)	M/s Usha compressors
3A	Chlorination System	M/s Chlorotech Equipment' Pvt Ltd
		M/s Capco Water Solutions Pvt

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		Ltd
		M/s Banaco
		M/s Denora
3 B	Pneumatic Operated Auto Shut off Valve System of Chlorine Toner Route Valve	M/s Hydro Dynamic - UK
		M/s Helogen - USA
		M/s Banaco
		M/s Chlorotech Equipmen'Pvt Ltd
4	Cranes (EOT, Hoists, Jib cranes)	M/s W.H. Brady
		M/s Transpade Engineers
		M/s Mangala Hoists Pvt Ltd.
5	Centrifuge Decanter/Volute Screw Press	M/s Pennwalt
		M/s GEA Westfalia
		M/s Alpha Laval
		M/s SBS Enviro Aqua Concepts Pvt. Ltd
		M/s Micro Transmission
		M/s Tega Mcnally Minerals Limited
6	Exhaust Fans	M/s Alstom
		M/s Howden
		M/s Bajaj
		M/s Crompton
		M/s Almonard
7	Flash Mixer/ Agitator/Sludge Mixer	M/s Verito Engineering Pvt Ltd.
		M/s Remi Process
		M/s Milton Roy
		M/s Apollo Screens Private Limited
8	Horizontal Centrifugal Pumps	M/s KBL
		M/s Grundfos
		M/s Aqua Machineries Pvt Ltd.
		M/s KSB
		M/s SBS
9	Submersible Pumps	M/s KSB
		M/s Xylem
		M/s ABS Sulzer
		M/s Grundfos

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		M/s Kishor
		M/s Aqua Machineries Pvt Ltd.
		M/s SBS
10	Submersible Pumps-Tube installed	M/s ABS Sulzer
		M/s Xylem
		M/s Wilo
		M/s Grundfos
		M/s KSB
		M/s Aqua Machineries
11	Progressive Cavity Screw Pumps	M/s Rotomac Pumps
		M/s Netzch technology
		M/s PD Pumps
		M/s Tushaco Pumps
		M/s Roto Pumps
12	Chemical Dosing Pumps & Dry Polymer Feeder	M/s Milton Roy
		M/s Verito Engineering Pvt Ltd.
		M/s Positive Metering Pumps
		M/s Swelore
		M/s SR Metering Pumps
13	Submersible Mixer	M/s ABS-Sulzer
		M/s Grundfos
		M/s KSB
		M/s ITT FLYGT-Xylem
		M/s Aqua Machineries
		M/s Euro Tech
		M/s FUCHS Enprotec GmbH
14	Clarifiers and Thickener Mechanism	M/s Micro-Transmission
		M/s Voltas
		M/s Shivpad
		M/s Emco KCP
15	Vortex Grit Mechanism	M/s Micro-Transmission
		M/s Huber
		M/s Smith & Lovels
		M/s Ekoton
		M/s Ovivo
		M/s Apollo Screens Private Limited
	Butterfly Valve	M/s AVK Valves

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
16		M/s Well Cast Industries
		M/s KBL
		M/s Jupiter
		M/s DVPL- Durga
		M/s Chandranchal Entrerprises Pvt Ltd.
17	Sluice Gate Valve	M/s Chandranchal Entrerprises Pvt Ltd.
		M/s Well Cast Industries
		M/s KBL
		M/s AVK
		M/s Jupiter
		M/s DVPL- Durga
18	PP Valve	M/s Shenco
		M/s U N Poly valves
19	Penstock Gates	M/s Jash
		M/s Micro-Transmission
		M/s DVPL- Durga
		M/s AVK
20	M.S- Cement Lined Pipes	M/s Welspun
		M/s Mohan Hume Pipes
		M/s Hydroflow
21	SS Pipes	M/s. Sunmark Stainless Pvt Ltd.
		M/s Pipe Chem Industries
22	CI/DI/GI pipes	M/s Electro steel
		M/s Chandranchal Entrerprises Pvt Ltd.
		M/s Lanco steel
		M/s Kejriwal Castings
23	DI Pipe Fittings	M/s Chandranchal Entrerprises Pvt Ltd.
		M/s Kejriwal Castings
24	Motorized Weir Gates	M/s Jash
		M/s DVPL- Durga
25	Chlorine Tonners	M/s ISGEC

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		M/s Meenakshi Associates
26	Fine Bubble Diffusers	M/s Rehau
		M/s Southern Scogen
		M/s Euro Tech
		M/s SSI Aeration
27	Centrifugal Air Blowers	M/s Howden
		M/s Gardener Denver
		M/s GL-Turbo
28	Turbo Air Blowers	M/s Howden
		M/s Usha Neuros Turbo LLP
		M/s Godrej Aerzen
		M/s Turbo Max
		M/s Turbo Win
		M/s Gardener Denver
		M/s GL- Turbo
		M/s Sprintex
29	Mechanical Screens/Fine Screens/Manual Screens/Belt Conveyor	M/s Jash Engineering
		M/s Ekoton (Eurotech)
		M/s Huber
		M/s Micro Transmission
		M/s Eva Screens Ltd.
		M/s Apollo Screens Private Limited
30	Hot water Boiler	M/s Thermax Limited
		M/s Rakhoh
		M/s Thermal Engitech
		M/s Cethar Limited
		M/s Cheema Boilers Ltd.
31	Electric Actuators	M/s Auma
		M/s Limitork
		M/s Rotork
32	Pneumatic Actuators	M/s Rotex
		M/s D Torque
		M/s Elomatic
	UPVC & HDPE Pipes	M/s Finloex

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
33		M/s Duraline
		M/s Manikya Plastichem
		M/s Pennwalt Agro
		M/s Supreme
		M/s Prince Pipe & Fittings
34	Motors	M/s Crompton Greaves Ltd
		M/s Marathon Electric (Alstom)
		M/s Kirloskar Electric company
		M/s Bharat Bijlee Ltd
		M/s ABB
35	Ball Valves	M/s BDK Engineers
		M/s Well Cast Industries
		M/s Flowchem
		M/s Virgo
		M/s KBL
		M/s Micro finish
36	Knife Gate valves	M/s Jash Engineering (Scheute)
		M/s Fouress
		M/s AVK
		M/s Jupiter
		M/s DVPL-Durga
		M/s Well Cast Industries
37	Diaphragm valves	M/s Crane Process
		M/s Micro finish
		BDK Engineers
		M/s Leader
38	Eccentric Plug valves	M/s Dezurik
		M/s VAAS
		M/s Arflu
39	Alum Rapid Induction Mixer	M/s Rite water solution
		M/s Verito Engineering Pvt Ltd.
40	Biogas Scrubber	M/s Innovative Environmental
		M/s Combustion research associates
		M/s United Enviro System
		M/s Vair System

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
41	Gas Flare	M/s Combustion research associates
		Equivalent makes can be proposed which meets the qualification criteria mentioned below.
42	Heat Exchanger	M/s Alpha Laval
		M/s Positron Engineering Corporation
		M/s Ammus
		M/s Rakhoh
		Equivalent makes can be proposed which meets the qualification criteria mentioned below.
43	Air conditioner	M/s Blue star
		M/s Voltas
		Equivalent makes can be proposed which meets the qualification criteria mentioned below.
44	Screw Impeller Submersible Pumps	M/s Hydrostal
		M/s Kubota Pumps
		Equivalent makes can be proposed which meets the qualification criteria mentioned below
45	Screw Turbine Hydro Power Generation System	M/s JASH Engineering
		M/s REHART
		M/s KAUS-Gmbh
		M/s SPAANS
		Equivalent makes can be proposed which meets the qualification criteria mentioned below
46	Biogas Mixing (Sliding Vane) Blowers	M/s Swam
		Equivalent makes can be proposed which meets the qualification criteria mentioned below
47	Biogas Engine & Auxiliary Power Generation System	M/s GE Jenbacher
		M/s Waukesha Engines
		M/s Caterpillar Biogas Engines
		Equivalent makes can be proposed

	CONSOLIDATED MECHANICAL EQUIPMENT VENDOR LIST	
S.NO.	**ITEM DESCRIPTION**	**APPROVED VENDOR/ MANUFACTURER/ MAKE**
		which meets the qualification criteria mentioned below
48	Disc Filters	M/s Aqua Aerobic
		M/s Huber
		M/s Mita (Eurotech)
		M/s Yucheon
		M/s Micro Transmission
		M/s Premier Tech Water and Environment
		M/s Grenex
49	Alum Dosing Tank	M/s Janmeja Technologies
		M/s Verito Engineering Pvt Ltd.
50	Alum Solution Tank Mixer	M/s Milton Roy
		M/s Verito Engineering Pvt Ltd.
51	Macerators	M/s Vogelsang
		M/s Sulzer Pumps Wastewater Malaysia
52	Trash Racks (Screens)	M/s JASH
		M/s Huber
		M/s EuroTech
		M/s Micro Transmission
		M/s Apollo Screens Private Limited
53	Centrifuge /Thickener	M/s EuroTech
		M/s Hiller
		M/s Alfa Laval
		M/s GEA
		M/s Micro Transmission
54	Rectangular Clarifiers	M/s Finnchain
		M/s DEWA
55	Ultrafiltration System	M/s Kubota
		M/s Dupont (Memcor)
		M/s Mitsubishi
		M/s Mann Hummel

All the equipment, to be supplied under this contract has to be from experienced manufacturer. The equipment of only those manufacturers, who have sufficient proven experience of manufacturing the

respective equipment of similar capacity, shall be considered. The naming of a manufacturer in this specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a standard of excellence for the material used, and to indicate a principle of operation desired.

In order to achieve standardization for appearance, operation, maintenance, spare parts and manufacturer's service, like items of equipment provided hereunder shall be the end products of one (1) manufacturer.

Note: - The contractor shall ensure that the equipment shall be offered for inspection as per approved QAP at the OEM original place of manufacturing facility only. In the event of any assembled/third party sourced equipment, the equipment shall be offered as a complete unit at the OEM original place of manufacturing facility only as indicated above.

The contractor shall ensure that the proposed equipment shall comply to the contract specifications and the contractor shall ensure that the equipment being proposed is in compliance to the same before submitting the document for review and approval. Any non-compliance, the contractor shall be fully responsible for the delay.

In the event that the contractor wishes to propose alternate makes for the equipment mentioned above, he shall submit the following:

1. Demonstrate that the proposed makes are “equivalent ” to the approved makes. The contractor shall ensure that alternate makes proposed, shall comply completely to the tender specifications, before the same is submitted for approval.
2. Submit ISO certificates for the OEM.
3. Submit quality certificates that the equipment adheres to, as required under this contract.
4. Submit product brochures for the proposed equipment, with information on spares availability and service setup in employer’s country.
5. Manufacturer involved in manufacture of specified proposed equipment for at least 10 years before bid date.
6. End user performance certificates for minimum 10 successful individual installations of similar size as per this contract with the proposed equipment and model no, commissioned in last 5 years before bid date and satisfactorily operating for at least five years before bid date. Contractor to submit end user reference certificates for each of the installations referenced.
7. Manufacturer to provide full contact information for each reference as part of submission.

And the above qualities and requirements shall be demonstrated and evidenced by inspection of manufacturing units and successfully installed plants (at the End users plant/premises) for the equipment’s desired and successful operation and certification by the Employer/Engineer (BWSSB)/Representative.

The Employer shall reserve the right to accept or reject the Bidder proposed makes of Equipment.

8.40 Warranty

A. Comply with the requirements of each type of Equipment and specification mentioned elsewhere in this document.

B. Warrant all components to be free of defects in materials or workmanship for 12 months from date of satisfactory completion of performance test.

C. Individual warranties by component manufacturer in lieu of single source responsibility by the main Equipment manufacturer shall not be acceptable.

D. Items which fail during the warranty period, excluding expendable items, shall be replaced without cost to the Owner.

E. Provide manufacturer's guarantee and warranty certificates prior to equipment start-up.

8.41 Pipelines, Pipe work and Fittings

8.41.1 Applicable codes

The following codes and standards unless specified herein shall be referred to, or equivalent to the approval of Engineer.

8.41.2 Materials

IS :	210	Specification for grey iron casting
IS :	290	Specification for coal tar black paint
IS :	456	Code of practice for plain and reinforced concrete
IS :	458	Specification for pre cast concrete pipes (with and without reinforcement)
IS :	516	Method of test for strength of concrete
IS :	638	Specification for sheet rubber jointing and rubber insertion jointing
IS :	783	Code of practice for laying of concrete pipes
IS :	816	Code of practice for use of metal arc welding for general construction in mild steel
IS :	1367	Technical supply conditions for threaded steel fasteners
IS :	1387	General requirements for the supply of metallurgical materials
IS :	1500	Method for Brinell hardness test for metallic materials
IS :	1536	Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage
IS :	1537	Specification for vertically cast iron pressure pipes for water, gas and sewage
IS :	1538	Specification for cast iron fittings for pressure pipes for water, gas and sewage
IS :	1916	Specification for steel cylinder pipes with concrete lining and coating
IS :	2078	Method for tensile testing of grey cast iron
IS :	3597	Method of tests for concrete pipes
IS :	3658	Code of practice for liquid penetrant flow detection
IS :	5382	Specification for rubber sealing rings for gas mains, water mains and sewers
IS :	5504	Specification for spiral welded pipes
IS :	6587	Specification for spun hemp yarn
IS :	7322	Specification for specials for steel cylinder reinforced concrete pipes

8.41.3 Code of Practice

IS :	783	Code of practice for laying of concrete pipes

IS : 3114 Code of practice for laying of cast iron pipes
IS : 3764 Excavation work - Code of Safety
IS : 4127 Code of practice for laying of glazed stoneware pipes
IS : 5822 Code of practice for laying of electrically welded steel pipes for water supply.
IS : 6530 Code of practice for laying of asbestos cement pressure pipes.

8.41.4 Materials for Pipelines

Each pipeline shall be constructed in a material compatible with the fluid conveyed through that pipeline, i.e. the materials used in the pipes which are or can be in contact with the untreated or treated sewage, shall not contain any matter which could impart taste or odor or toxicity or otherwise be harmful to health or adversely affect the sewage conveyed. Nor shall any pipe be adversely affected by the fluid being conveyed through that pipe.

Pipe work and valve materials for the following duties shall be as follows or equivalent to the approval of the Engineer:

Table 8.1 Pipe work and Valve Materials

Application / Location	**Material**
Chlorine: Drum connections	Cadmium plated 70/30 copper nickel CN 107, BS 2871 : Part 1 (strictly as per ASTM-B-88 of 16 SWG pipe)
Chlorine gas or liquid	flanged or welded carbon steel, CAF flanged joints (Strictly as per ASTM-B-106 with minimum 6000 LBS Fittings)
Chlorine gas lines below atmospheric pressure Chlorine solution Polyelectrolyte dosing line Alum	Rigid UPVC sch. 40 minimum PVC Sch. 40 minimum Valves shall be globe type with forged steel bodies, monel spindles, stainless steel seats and PTFE gland packing or carbon steel, monel plug, PTFE sleeved plug UPVC/HDPE HDPE (High density polyethylene) Reference standard IS 4984 PE-100 latest revision.
Water: Raw Sewage, Process sewage, dirty waste water, supernatant and treated Sewage/Effluent, Process sludge Digester Gas	Mild Steel with mortar lining/Guniting (Beyond 1100mm diameter of pipe) or Ductile Iron K9 (Up to 1100mm). MS pipe thickness shall be as per IS 3589 latest revision. SS316 of Schedule 10 pipe wall thickness, for Header

Application / Location	Material
	and distribution pipe at top of digester, interconnection pipes in the plant. Reference standard ASME B36.19M latest revision.
Service water	GI (below 80mm), ductile iron (80mm and above).
Air: Process Air & Backwash Air	All Air Supply pipes shall be of SS316 construction and of schedule 10S.

8.41.5 Ductile Iron Pipes and Fittings

8.41.5.1Pipes and Fittings

(a) General

Ductile iron pressure pipes and fittings (Class K9) shall comply with IS 8329 and IS 9523. All fittings shall be socketed unless specified otherwise.

(b) Materials

The materials used in the manufacture pipes and fittings shall comply with IS 8329 and IS 9523.

(c) Tests

Tests on pipes and fittings shall be carried out in accordance with IS 8329 and IS 9523. The test method shall be submitted for approval of Engineer.

The Engineer shall be permitted free access to the place of manufacture for the purpose of examining, inspection and witnessing the testing of pipes and fittings.

8.41.5.2 Joints

(a) Spigot and Socket Joints

These shall have sockets which are integral with the pipe and incorporate an elastomeric rubber ring gasket conforming to IS :5382-1969 (Latest edition/revision with amendments, if any).

(b) Flanged Joints

These shall comply with dimensions and drilling details shall be to BS EN 1092-1/BS: 4504 Table10/11 and16/11. All flanged joints between steel and ductile iron pipe work shall be electrically isolated joints. These shall have isolation gaskets between the flanges, isolation sleeves around all bolts and isolation

washers under all bolt heads and nuts. All materials shall be supplied by a specialist manufacturer and be to the approval of the Engineer.

8.41.5.3 Linings

Ductile iron pipes and fittings shall have a cement mortar lining, in accordance with IS 11906 or ISO 4179.

Pipe linings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer. The Contractor may use specialist mortars, mortar additives or curing agents only with the approval of the Engineer.

Certain sections are amplified as follows:

No additives shall be used without the written approval of the Engineer, and shall be used strictly in accordance with the manufacturer's recommendations.

The minimum thickness of the lining at one point shall not be less than 4 mm.

8.41.5.4 Coating

(a) General

Ductile iron pipes and fittings shall be zinc coated with bitumen over coating, all in accordance with the following Specifications. Buried pipes and fittings shall also have a site or factory applied polythene sleeving. Pipe coatings shall be inspected on site and any damage or defective areas made good to the satisfaction of the Engineer.

(b) Zinc Coating

Zinc coating shall comply with ISO 8179 and shall be applied as a spray coating. The mass of sprayed metal shall not be less than 130 g/m^2 as described in Clause 5.2 of ISO 8179.

(c) Bitumen Coating

Bitumen coating shall be of normal thickness 0.07 mm unless otherwise specified. It shall be a cold applied compound complying with the requirements of BS 3416 Type II, suitable for tropical climates, factory applied in accordance with the manufacturer's instructions.

Damaged areas of coating shall be repainted on site after removing any remaining loose coating and wire brushing any rusted areas of pipe.

(d) Polythene Sleeving

Where polythene sleeving is specified (generally for all buried DI pipes need sleeve covering) to be applied in addition to bitumen coating it shall comply with ISO 8180. Site applied sleeving shall be

stored under cover, out of direct sunlight, and its exposure to sunlight shall be kept to a minimum. Pipes having a factory applied sleeving must be stored in the same conditions.

8.42 Reinforced Cement Concrete Pipes

8.42.1 Design

Design of RCC pipes including reinforcement details and the ends of pipes shall be in accordance with the relevant clauses of IS: 458.

8.42.2 Manufacturing

General

The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant clause of IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

The RCC pipes and collars/rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.
The Engineer shall at all reasonable times have free access to the place where the pipes and collars/rubber rings are manufactured for the purpose of examining and testing the pipes and collars/ rubber rings and of witnessing the test and manufacturing.

All tests specified either in this Employer's Requirements or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot. The decision of the Engineer in this matter shall be final and binding on Contractor and not subject to any arbitration or appeal.

8.42.3 Materials

For all materials Factory's test result, and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the Engineer before carrying to sites.

(a) Cement

Cement used for the manufacture of RCC pipes and collars shall conform to relevant IS codes. The use of pozzolana as an admixture to Portland cement shall not be permitted.

(b) Aggregates

Aggregates used for the manufacture of RCC pipes and collars shall conform to IS: 383. The maximum size of aggregate should not exceed one third the thickness of the pipe or 20mm, whichever is smaller.

(c) Mixing and Curing Water

Water shall be clean, colour less and free from objectionable quantities of organic matter, alkali, acid, salts, or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar. Contractor shall submit water quality report before using it.

(d) Reinforcement

Reinforcement used for the manufacture of the RCC pipes and collars shall be mild steel Grade I or medium tensile steel bars conforming to IS:432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (part-2). Reinforcement cages for pipes and collars shall be as per relevant requirement of IS:458.

(e) Concrete

Concrete used for the manufacture of RCC pipes and collars shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15 cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

(f) Curing

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

(g) Dimensions

The internal diameter, wall thickness and length of barrel and collar of pipes, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS:458 for different classes of pipes.

The tolerances regarding overall length, internal diameter of pipes or sockets and barrel wall thickness shall be as per relevant clause of IS: 458.

(h) Workmanship and Finish

Pipes shall be straight and free from cracks. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight line in the trench no opening between ends in contact shall exceed 3 mm in pipes upto 600mm diameter (inclusive), and 6 mm in pipes larger than 600 mm diameter.

The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between the Engineer and the manufacturer or supplier.

The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

The pipes shall be free from local dents or bulges greater than 3 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

The deviation from straight in any pipe throughout its effective length, tested by means of rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters 3 mm for every meter run.

(i) Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances as mentioned in IS: 458.Engineer reserve the right to attend all testing.

During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by the Engineer the results of compressive tests of concrete cubes and split tensile tests of concrete cylinders made from the concrete used for the pipes. The manufacturer shall supply cylinders or cubes for test purposes required by the Engineer and such cylinders or cubes shall withstand the tests prescribed as per IS:458. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure. For non-pressure pipes, 2 percent of the pipes shall be tested for hydrostatic test pressure.

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 458 and tests in accordance with the methods described in IS: 3597.

i) Hydrostatic test
ii) Three edge bearing test
iii) Absorption test
iv) Visual Examination

(j) Sampling and Inspection

In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to the requirements of this Employer's Requirements shall be ascertained on the basis of tests on pipes selected from it.

The number of pipes to be selected from the lot for testing shall be in accordance with Table 15 of IS: 458.

Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every pipe be selected till the requisite number is obtained, or being the integral part of N/n where N is the lot size and n is the sample size.

All pipes selected shall be inspected by Engineer for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

The number of pipes to be tested shall be in accordance with column 4 of Table 15 of IS:458. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause.

A lot shall be considered as conforming to the requirements of IS:458 if the following conditions are satisfied.

The number of defective pipes shall not be more than the permissible number given in column 3 of Table 15 of IS: 458.

All the pipes tested for various tests shall satisfy corresponding requirements of the tests.

In case the number of pipes not satisfying requirements of any one or more tests, one or two further samples of same size shall be selected and tested for the test or tests in which the failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

All result of tested data must be prepared by contractor at site so that the Engineer shall make decision of "fail or pass" at once. All cost for the test shall be borne by the Contractor.

(k) Marking

The following information shall be clearly marked on each pipe:

a) Internal and External diameter and length of pipe
b) Class of pipe
c) Date of manufacture and
d) Name of manufacturer or his registered trade-mark or both.

8.43 Jointing

a. **General**

Jointing of RCC pipes shall be done as per the requirements of following Employer's Requirements and as per the relevant IS standard. After jointing, extraneous material, if any, shall be removed from the inside of the pipe and the newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

Spigot and Socket joint (Rigid)

The spigot of each pipe shall be slipped home well into the socket of the pipe previously laid and adjusted in the correct position. The opening of the joint shall be filled with stiff mixture of cement mortar which shall be rammed with caulking tool. This joint is used for low pressure pipe line.

b. Collar Joint (Rigid)

After laying the RCC pipes at proper alignment and gradient their abutting faces shall be coated with hot bitumen in liquid condition by means of a brush. The wedge-shaped groove in the end of the pipe shall then be filled with a tarred gasket in one length for each joint. The collar shall then be slipped over the end of the pipe and the next pipe butted well against the tarred gasket by suitable appliances approved by the Engineer so as to thoroughly compress the tarred gasket into the grooves, care being taken that the concentricity of the pipes and levels are not disturbed during this operation.

The collar shall then be place symmetrically over the end of the two pipes and the space between the inside of the collar and the outside of the pipe filled with a mixture of cement and sand to withstand any stress and prevent any water leakage, tempered with just sufficient water to have a consistency of the semi-dry conditions, well packed and thoroughly rammed with caulking tools. The joints shall be finished off with a fillet sloping at 45^0 to the side of the pipe. The finished joints shall be protected and cured thoroughly as directed by the Engineer. Any plastic solution or cement mortar that may have been squeezed into the inside of the pipe shall be removed so as to leave the inside of the pipe perfectly clean.

c. Flush Joint (Internal)

This joint shall be generally used for culvert pipes of 900 mm diameter and over. The ends of the pipes are specially shaped to form a self-centering joint with an internal jointing space 13 mm wide. The finished joint is flush with both inside and outside with the pipe wall. The jointing space is filled with cement mortar mixed sufficiently dry to remain in position when forced with a trowel or rammer.

d. Flush Joint (External)

This joint is suitable for pipes which are too small for jointing from inside. This joint is composed of specially shaped pipe ends. Each end shall be butted against each other and adjusted in correct position. The jointing space shall then be filled with cement mortar sufficiently dry and finished off flush. Great care shall be taken to ensure that the projecting ends are not damaged as no repairs can be readily affected from inside the pipe.

e. Spigot and Socket (Semi-flexible)

This joint is composed of specially shaped spigot and socket ends on the RCC pipes. A rubber ring shall be lubricated and then placed on the spigot which is forced into the socket of the pipe previously laid. This compresses the rubber ring as it rolls into the annular space formed between the two surfaces of the spigot and socket, stiff mixture of cement and mortar shall then be filled into the remaining annular space with a caulking tool.

f. Collar Joint (Semi-Flexible)

This joint is made up of a loose collar which covers two specially shaped pipe ends. Each end shall be fitted with a rubber ring which when compressed between the spigot and collar, seals the joint. Stiff

mixture of cement mortar shall then be filled to withstand stress and prevent any water leakage, into the remaining annular space and rammed with a caulking tool.

g. Spigot and Socket Joint (Flexible)

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipe by means of uniformly applied pressure with the aid of a jack or similar appliance. The RCC pipes shall be of spigot and socket type and rubber rings shall be used, and the manufacturer's instructions shall be deemed to form a part of these Employer's Requirements. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

h. Cleaning of Pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by the Engineer, Contractor shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75 mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

It shall also be ascertained by contractor that each stretch from manhole to manhole or the stretch as directed by Engineer is absolutely clear and without any obstruction by means of visual examination of the interior of the pipe line suitably enlightened by projected sunlight or otherwise.

i. Testing at work site

After laying and jointing of RCC pipes is completed the pipe line shall be tested at work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be contractor's responsibility and shall be rectified by him to full satisfaction of the Engineer. Water used for the test shall be removed from pipes and not released to the excavated trenches.

After the joints have thoroughly set and have been checked by the Engineer and before back filling the trenches, the entire section of the sewer or storm water drain shall be proved by the contractor to be water tight by filling in pipes with water to the level of 1.50m above the top of the highest pipe in the stretch and heading the water up for a period of one hour. The apparatus used for the purpose of testing shall be approved by the Engineer. Contractor if required by the Engineer shall dewater the excavated pit and keep it dry during the period of testing. The loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular 10 minutes intervals and noting the quantity required to maintain the original water level. For the approval of this test the average quantity

added should not exceed 1 liter/ hour/100 linear metres/ 10mm of nominal internal diameter. Any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

In case of pressure pipeline, the completed stretch of pipeline shall be tested for site test pressure. The site test pressure should not be less than the maximum operating pressure plus the calculated surge pressure, but in no case should it exceed the hydrostatic test pressure as specified in IS: 458.

All of results of test and inspection data must be prepared by contractor at site so that the Engineer shall make decision of "fail or pass" at once. All cost for the inspection shall be borne by the Contractor.

8.44 Steel Cylinder Pipes and Specials

8.44.1 Design

In general, the design of steel cylinder pipes with concrete lining and coating shall conform to clause 8 of IS 1916. In addition to above, in case of buried pipe line, the pipe shall also be designed for the Earth load, and traffic load.

8.44.2 Manufacturing

(a) General

Steel cylinder pipes and specials with concrete lining and coating shall be systematically checked for any manufacturing defects by experienced supervisors and a very high standard of quality shall be maintained. The pipes and specials shall be inspected by Engineer at site and factory, and defects noticed, if any, such as protrusions, grooves, dents, notches, etc. shall be rectified, if agreed to by the Engineer. Care shall be taken that the resulting wall thickness does not become less than the minimum specified. If the wall thickness becomes less than the minimum specified, as per Table 1 of IS: 1916, the damaged portion should be cut out as cylinder and replaced by an undamaged piece of pipe at no extra cost to the Engineer.

The Engineer shall at all reasonable times have free access to the place where the pipes and specials are manufactured for the purpose of examining, inspection and testing the pipes and specials and for witnessing the test and manufacturing.

All tests specified either in this Employer's Requirement or in the relevant Indian Standards shall be performed by Supplier/Contractor at his own cost and in presence of the Engineer, if desired. For this sufficient notice before testing of the pipes and specials shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes and specials of that lot. The decision of the Engineer in this matter shall be final and binding on the Contractor.

(b) Materials

All material shall conform to Clause 7 of IS 1916.

(c) Manufacturing Process

Steel cylinder pipes with concrete lining and coating shall be manufactured as per Clause No.9 of IS: 1916 and specials shall be manufactured as per Clause 7 of IS:7322. In case of spiral welded pipes, they shall be manufactured as per Clause 3 of IS: 5504. Internal lining shall be upto the full length of the pipes and specials. However, external coating shall be done leaving about 100 mm length of the pipes and specials from their ends. The internal lining and external coating to pipes and specials shall be done at factory. Before lining/coating by concrete/mortar the surface of pipes and specials shall be thoroughly cleaned. In the event that loose mill scale, tuberculation, or an accumulation of dirt, debris, oil or grease is present, it shall be removed from the surface by hand, by machine or both and given a coating of neat cement slurry.

(d) Dimensions

The clear cover to the reinforcement whether steel cylinder or cage shall be not less than 9 mm for lining of pipe/special and 12 mm for coating of the pipe/special.

The permissible tolerance for diameter and length of pipe shall be as per Clause 4 of IS: 1916, whereas for diameter, arm length and angular deviation of specials the tolerance limit shall be as per Clause 6 of IS: 7322.

(e) Workmanship and Finish

Workmanship and finish of pipe shall conform to Clause 4 of IS: 1916.

(f) Testing

Each steel cylinder shall be subjected before lining/coating to a hydrostatic test under a water pressure equivalent to the test pressure in accordance with Clause 10 of IS:1916 and relevant provisions of IS:3597, provided that the whole of the area of the calculated reinforcement is used in the steel cylinder. In the case of pipes where a part of the principal reinforcement is provided in the cage, the steel cylinder shall be subjected to proportionately less hydrostatic test pressure.

Manufacturer's standard specials shall be hydrostatically tested before lining/coating. Where feasible, other specials shall be hydrostatically tested (before lining/coating) at factory. However, when this is not practicable, at the discretion of the Engineer, the unlined specials shall be tested by penetration test as per IS: 3658 or other approved means.

All of results of test and inspection data must be prepared by contractor at site so that the Engineer shall make decision of “fail or pass” at once. All cost for the inspection shall be borne by the Contractor

(g) Penetration Test

A suitable liquid penetrant (kerosene oil/Dye) is applied to the surface of the portion under examination and is permitted to remain there for sufficient time to allow the liquid to penetrate into any defects open at the surface. After the penetrate time, the excess penetrant which remains on the surface, is removed. Then a light-colored powder absorbent called a developer is applied to the surface. This developer acts as

a blotter and draws out a portion of the penetrant which had previously seeped into the surface openings. As the penetrant is drawn out it diffuses into the coating of the developer, forming indication of the surface discontinuities or flaws.

(h) Marking

The following information shall be clearly marked on each pipe and special:

i) Internal diameter, external diameter and thickness
ii) Class of pipe and special with its serial number
iii) Date of manufacture and
iv) Name of manufacturer or his registered trade mark or both

(i) Jointing

Jointing of steel cylinder pipes and specials with concrete lining and coating be done as per the relevant IS. After jointing, extraneous material if any, shall be removed from the inside of the pipe and special. The welding of joints for pipes and specials at work sites shall comply with 816. Electrodes used for welding shall comply with IS: 814.

(j) Butt Welded Joint

After pipes and specials are laid in the trench, the faces of pipes/specials shall first be tack-welded alternately at one or more diametrically opposite pairs of points. After completing tack welding, full welding shall be carried out in suitable runs following a sequence of welding portions of segments diametrically opposite. After jointing the exposed surface of the steel cylinder of pipes and specials shall be coated with M20 cement concrete of sufficient thickness so as to make it flush with the adjoining both inner and outer faces of pipes and specials. The gap in the internal lining at the joints shall be filled with cement mortar (1:2) for pipes and specials larger than 600 mm diameter. The lining/coating shall be done after the field test in the section has been successfully completed.

(k) Lap Welded Joint with Slip-in-ends

In the case of pipes with plain or slip-in-ends, swaged end of the steel cylinder may be formed by heating one of its ends and expanding it or rolling it out to the required shape. The minimum depth and maximum clearance between the swaged end and the plain end of pipes for field welding shall be provided as directed by the Engineer. Lap welding shall be done from the external face at the junction of pipe and socket. After jointing the exposed surface of the steel cylinder of pipes and specials shall be coated with M20 cement concrete of sufficient thickness so as to make it flush with the adjoining both inner and outer faces of pipes and specials. The gap in the internal lining at the joints shall be filled with cement mortar (1:2) for pipes and specials larger than 600 mm diameter. The lining/coating shall be done after the field test in the section has been successfully completed.

(l) Flanged Joints

The flanges for steel cylinder pipes and specials shall be as per BS EN 1092-1/BS4504. Flanges shall be provided at the end of pipes or specials where valves, blank flanges etc. have to be introduced or flanged joints for the pipes are specified. The flanges shall have necessary bolt holes drilled. It might be necessary for contractor to follow the instructions and specifications given by the valve manufacturer. All bolts, nuts and packing material required for flanged joints shall be provided by the Contractor. Bolts and nuts shall conform to IS: 1367 whereas rubber gasket of required thickness shall conform to IS: 638.

The bolts shall be evenly tightened in comply with relevant BS standard. Random inspection shall be carried out by jointly the Engineer and the contractor.

(m) Cleaning of pipes and specials

Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipeline, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

(n) Testing at work site

After laying and jointing of steel cylinder pipes and specials with concrete lining and coating is completed the pipeline shall be tested at work site as per the following Employer's Requirements and as directed by the Engineer. All equipment for testing at work site shall be supplied and erected by Contractor. Water for testing of pipes shall be arranged by him. Damage during testing shall be Contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water used for test shall be removed from pipes and not released to the excavated trenches.

Each section of the pipe line shall be slowly filled with clean water and all air shall be expelled from the pipeline. The pressure in the pipeline should then be raised and maintained by means of pump to the test pressure. The test pressure should not be less than 1 1/2 times the working pressure at the lowest point or the static head pressure, whichever is higher. Under the test pressure no leak or sweating shall be visible at the welded joints. The duration of test shall be not less than 24 hours. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be rewelded. Any cracked or defective pipes and specials in consequences of this pressure test shall be removed and replaced by sound material by Contractor and the test shall be repeated to the satisfaction of the Engineer.

Proper arrangement of thrust blocks shall be provided during pressure testing or pipe laying works.

8.45 Steel Pipe work

Pipe/fitting material and dimensional standard shall conform to following:

Size mm (NB)	**Material Specification (Mild Steel)**	**Dimensional Standard (Mild Steel)**	**Material Specification (Stainless Steel)**	**Dimensional Standard (Stainless Steel)**
Pipes upto 150 mm	1239 PT, ERW, Black PT-1 HVY	1239 ERW	ASTM A 312	ANSI B 36.19
200 to 2400	2062	3589 – ERW 3589 for dimensions and minimum thickness. Pipe thickness shall be as per 2825	ASTM A 312/A358	ANSI B 36.19
Elbows upto 25	ASTM–A 105	ANSI B 16.11 3000 # S.W.	ASTM A 182	ANSI B 16.11
40 to 150	ASTM-A 234 GR WPB	ANSI B 16.9	ASTM A 403	ANSI B 16.19
200 & above (meters)	2062	LR. BE. Sch 40 ANSI B 31.1	ASTM A 403	ANSI B 16.19
Coupling upto 25	ASTM-A 105	ANSI B 16.11 3000 # S.W.	ASTM A 182	ANSI B 16.11 3000 S.W.
Tees 40 to 200	ASTM – A 234 GR WPB	ANSI B 16.9 BE, Sch 40	ASTM A 403	ANSI B 16.9 BE, Sch 40
Above 200	IS 2062	IS 2825 (min. Pipe thickness)	ASTM A 403	ANSI B 16.9 BE, Sch 40
Reducers upto 25	ASTM-A 105	ANSI B 16.11 3000 S.W.	ASTM A 182	ANSI B 16.11 3000 S.W.
40 to 200	ASTM-A 234 GR WPB	ANSI B 16.9 BE, Sch 40	ASTM A 403	ANSI B 16.9 BE, Sch 40
Above 200	2062	IS 2825 (min. Thickness for larger pipes)	ASTM A 403	ANSI B 16.9 BE, Sch 40
Flanges	2062	BS EN 1092-1	ASTM A 182	BS EN 1092-1
Bolts, Anchor Bolts and all nuts	SS316	1364	SS316	1364
Gaskets All	638 (rubber) reinforced	3 mm thickness	638 (rubber) reinforced	3 mm thickness

Facilities shall be provided for draining the pipe system and releasing air.

The pipe work layout within pump stations shall have the approval of the pump manufacturer. Fluid velocities in suction pipe work leading to pumps shall not exceed 1.5 m/s. Fluid velocities in delivery pipe work leading from pumps shall not exceed 2.0 m/s.

The whole of the jointing work and materials necessary to fix and connect the pipes, including adequate and efficient pipe support shall be included in the Contract. The Contractor shall be responsible for ensuring that the internal surface of all pipe work is thoroughly cleaned before and during erection and before commissioning.

Cleaning shall include removal of all dirt, rust, scale and welding slag due to Site welding. Before dispatch from the manufacturer's works, the ends of the pipes, branch pipes, etc., shall be suitably capped and covered to prevent any accumulation of dirt or damage. This protection shall not be removed until immediately prior to connecting adjacent pipes, valves or pumps. All small bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment. No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Employer.

Hydrostatic shop test for pipes and fittings shall be as per code/standard requirement. After erection at site, complete pipes and fittings shall be hydrostatically tested for a pressure of 1.5 times operating pressure.

Flanges, if fabricated in segments shall be fully radiographed and stress relieved. If fabricated out of billets/bars by cold rolling, welded flanges shall be radiographed and normalized.

Protection for pipes laid underground shall be by coating and wrapping system giving a final coat thickness of 4.5 mm may be employed. Such protection shall comprise 1.5 mm of coal tar primer application on a thoroughly cleaned surface, to be followed with fiber glass wraps set in coal tar enamel coats conforming to American Water Works Association Specification C/203/57 for a total thickness of 3 mm. Such lining shall meet a spark test to be approved with a holiday detector of 10000 Volts.

The Contractor shall indicate on his detailed drawings what thrust blocks are required to anchor pipe work supplied by him. Particular care shall be taken to ensure that pipe work thrusts are, as far as possible, not transmitted to machinery or other associated apparatus.

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting from the pipe. Puddle flanges shall also be fitted where a water barrier is required. All puddle flanges shall be clearly shown on the drawings and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the prior approval of the Employer.

Buried pipes shall in addition be designed to withstand external loading exerted by soil, water, and live loads as relevant. The external ground water shall be taken at ground level for design purposes. Saddle type/bracket type support wherever required shall be designed and supplied for the above ground pipe lines.

All pipe joints shall be of the butt-welded type. End preparations and fabrication requirements shall generally conform to I.S. 2825. Flanges, if fabricated in segments, shall be fully radiographed and stress relieved.
Laying of welded steel pipes shall meet the requirements of I.S. 5822.

a) Welded Joints for Steel Pipes

Welding of joints in steel pipes shall be carried out manually by the metal arc welding process complying with AWWA Standard C206.

Before starting the welding of pipe joints in the Works the Contractor shall submit for the Engineer's approval details of the plant, methods and materials he proposes to use, including make and size of electrodes, number of runs, current strength and arrangements for air testing of individual joints.

Welding shall only be carried out by welders approved by the Engineer and each welder shall identify his work by means of a stenciled mark.

Welded joints other than for closing lengths shall be of the spherical spigot and socket type. For pipes of 675 mm diameter and smaller the pipe joint shall be welded externally. For pipes larger than 675 mm the pipe shall be welded internally and a sealing weld made externally.

All parts to be welded shall have loose scale, slag, rust, paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld run when it is completed. Pipes manufactured with longitudinal or spiral welds shall be lined up before jointing so that these welds are at least 15^{o} apart around the joint circumference.

For pipes larger than 900 mm diameter a triple run convex fillet weld shall be used. For pipes of 900 mm diameter or less a double run convex fillet weld shall be used. The minimum leg length of the fillet as deposited is to be equal to the full thickness of the pipe wall. The actual throat depth shall not be greater than 9/10th and not less than 7/10th of the minimum leg lengths as deposited. The depositing of the weld metal shall be carried out in such a manner as to ensure that all the welds have adequate root fusion and are of good clean metal free from cracks, gas holes, slag inclusions and all other impurities. The surface of the weld shall have an even contour with regular finish and shall indicate proper fusion with the parent metal. All slag shall be thoroughly removed after depositing each run of welding by light hammering with a chipping hammer followed by wire brushing. Any welds showing cracks or other cavities or in which the weld metal tends to overlap on to the parent metal without proper fusion or containing any other defects whatsoever shall be cut out and rewelded to the satisfaction of the Engineer at the Contractor's expense.

At closing lengths where two plain ended pipes are to be joined by a welded joint the gap between the two ends shall not exceed 75 mm. An external steel sleeve collar, of a thickness not less than that of the pipe itself and approximately 300 mm in length shall be placed centrally over the two ends to be jointed and the end of each pipe shall then be fillet welded to the sleeve collar in accordance with the above procedure.

No weld or adjacent parts of the pipe shall be painted prior to inspection by the Engineer.

b) Welder Performance Test

The Contractor shall submit for the Engineer's approval the names of persons whom he proposes to employ as welders with evidence that, as a minimum preliminary qualification, they have passed the qualifying tests prescribed in Clause 11 of BS 2633 and possessed certificates from an independent testing authority. The Engineer may further require any such person to perform satisfactory test welds

under Site conditions and on pipes similar to those for use in the Works, before approving his employment as a welder. The Contractor shall maintain an up-to-date list of welders approved by the Engineer and if ordered by the Engineer he shall remove from the approved list any welder whose workmanship, as demonstrated by the results of air pressure tests on individual welded joints, is below a reasonable standard of quality of consistency in the Engineer's opinion.

c) Testing of Welded Joints

Where directed by the Engineer welded joints on pipes larger than 675 mm diameter shall be subject to a nitrogen gas test after welding.

A tapped hole (approximately 6 mm diameter) shall be made in the socket end of each pipe by the Contractor and shall be fitted with a suitable non-return valve. Nitrogen, at 400 kPa pressure, shall then be pumped into the annular space between the spigot and socket and the pump disconnected.

If no drop in pressure occurs over the ensuing period of 30 minutes the test shall be deemed to be successful. If the test pressure cannot be maintained for 30 minutes all defects in the weld shall be cut back and rewelded and the test reapplied until successful. The cost of initial and subsequent testing of defective welds shall be at the Contractor's own expense.

The Contractor shall provide all items necessary for the nitrogen tests including compressor, valves, gauges and tubing.

d) Hydraulic Losses

The frictional losses due to fluid flow in pipe work shall be computed, based on the Hazen- William formula using C=110

a) Valves

The losses in mwc shall be calculated as per empirical formulas k= coefficient shall be taken as under.

k - for sluice valves	= 0.2
for butterfly valves	= 0.3
for non-return valves	= 1.5
for penstocks	= as furnished by the manufacturer with documentary evidence.

b) Fittings, specials

For specials like reducers, bell-mouths, tees, elbows, etc, the `k' values shall be as recommended by the British Hydromechanics Research Association (BHRA), Volume 5, in the BHRA fluid Engineering Series.

e) Pipe work Protection

All underground steel piping shall have their external surfaces protected by application of one coal tar enamel coat, wrapping of fiberglass, one more coat of enamel and a final wrap of enamel

impregnated fiberglass. Pipe surface shall be thoroughly cleaned by shot or sand blasting. Primer paint recommended by the enamel manufacturer for the grade of enamel used shall be applied over this cleaned surface within four hours of cleaning. The primer paint shall be thoroughly mixed and applied as recommended by the manufacturer and the coating shall be free of bubbles, globules, drips and runs. The primer shall be thoroughly dry before enamel is applied and the latter shall not be applied later than 3 days after application of primer. First flood coat of enamel shall be overlaid by a single spiral wrap of fiberglass overlapping at least 20 mm on pipe up to 250 mm diameter and 25 mm on larger diameter pipes. Enamel shall be heated slowly in clean kettles, equipped with indicating or recording thermometers (100°C to 350°C range), to the recommended temperature. The enamel shall be stirred continuously. It shall be seen that fiberglass impregnates in the flood coat. Second coat of enamel and second wrap of bitumen impregnated fiberglass shall be applied in the same way. The total thickness of the coating shall not be less than 2.5 mm. Each end of the pipe left bare for a distance of 150 mm for welding shall be hand coated and wrapped after field welding is completed and hydro tested. Testing of pipe protection shall be done as directed by the Engineer using elcometers, coating thickness guages, and bond test and holiday detectors.

f) External protection

All underground pipework having a cover less than 1.5 m and more than 4.5 m shall be encased with M 15 concrete of minimum 200 mm thick all around.

All underground pipelines having a cover more than 1.5 m shall be externally protected by guiniting of minimum 40 mm thick as per specification.

All above ground and pipes in galleries shall be externally painted with two coats of epoxy with minimum thickness of 180 microns.

g) Flexibility in Pipe work

The Contractor shall provide flexibility in the pipe work at joints in the main structures and shall submit proposals for the approval of the Engineer. Flexible joints or collars and cut pipes shall be allowed on all pipe work where necessary to allow for some margin of error in the building work. Wherever possible flexible joints shall be provided (as per Engineer's directive) with tie bolts or other means to transfer longitudinal thrusts as a whole so that external anchorages may be kept to a minimum. Flexible joints (SS 304 Bellows and Dismantling joints) shall also be provided for case of erection and future dismantling of all valves and Equipment. Particular care shall be taken to ensure that pipe work thrusts are not transmitted to machinery or associated apparatus.

The Contractor shall indicate on his detailed drawings what thrust blocks are required.

h) Puddle Flanges

Puddle flanges shall be fitted to pipes where the structure through which they pass is required to take thrust resulting form the pipe. Puddle flanges shall also be fitted where a water barrier is required. All

puddle flanges shall be clearly shown on the drawing and the resultant thrust clearly indicated. Puddle flanges shall only be fitted with the Engineer prior approval.

i) Small Bore Pipes and Hoses

Small bore pipes and hoses shall be of non-flame propagating materials. They shall be arranged for easy dismantling for cleaning where appropriate, and if screwed joint or joints formed by solvent welding are proposed for any chemical line, a sufficient number of flanged or flexible joints shall be provided to enable the pipe work to be removed in sections without working from one end to the other of a particular run. Tees and cocks shall also be provided at convenient points for the connection of a pressure water supply to flush pipe work through as required.

All pipes and hoses shall be labelled to enable individual lines to be identified throughout their run. Racks or trays shall be fixed to the duct walls or walls of tanks and buildings and the chemical pipes shall be fixed to these racks or trays with clips hich can easily be removed without dismantling adjacent pipes. The Contract includes for the supply and fixing of all such racks or trays. Full details of the type of hoses, pipes and racks of trays proposed, shall be submitted at the time of tendering.

j) Support of Pipe work and Accessories

All necessary supports, saddles, slings, fixing bolts and foundation bolts shall be supplied to support the pipe work and its associated equipment in an approved manner. Valve, meters, strainers, and other devices mounted in the pipe work shall be supported independently of the pipes to which they connect.

All brackets or other forms of supports, which can conveniently be so designed, shall be rigidly built up of steel by riveting or welding in preference to the use of castings.

No point of passage of pipes through floors or walls shall be used as a point of support, except with the approval of the Engineer.

After the collars and boxes or other fitting have been fixed in position, the floors, walls and roof structure will be made good by the Contractor.

8.46 Cast Iron Pipes

8.46.1 Manufacturing

a) General

C.I. pipes and fittings shall be systematically checked for any manufacturing defects by experienced supervisors and a very high standard of quality shall be maintained.

Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and for witnessing the test and manufacturing.

All tests specified either in this Employer's Requirements or in the relevant Indian Standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if desired. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

If the test is found unsatisfactory, the Engineer may reject any or all pipes and fittings of that lot. The decision of the Engineer in this matter shall be final and binding of the Contractor and not subject to any arbitration or appeal.

b) Materials

The general requirements relating to the supply of material shall be as per IS: 1387.

The material for pipes and fittings shall be of good quality cast iron conforming to IS: 210 (Grade -FG 150).

c) Dimensions

The internal diameter, thickness and length of barrel, dimensions of pipes and fittings shall be as per the relevant tables of IS: 1536/1537/1538 for different class of pipes and fittings.

The tolerances for pipes and fittings regarding dimensions and deviations from straight line in case of pipes shall be as per relevant IS codes.

The standard weight of uncoated pipes and fittings and the permissible tolerance shall be as per relevant IS codes.

d) Workmanship and Finish

The pipes and fittings shall be stripped, with all precautions necessary to avoid warping or shrinking defects. The pipes and fittings shall be free from defects, other than any unavoidable surface imperfections which result from the method of manufacture and which do not affect the use of the pipes in the opinion of Engineer.

The pipes and fittings shall be such that they could be cut, drilled or machined and may be accepted provided the hardness of the external unmachined surface does not exceed 230 HBS. In the case of spigot and socket pipes and fittings for lead joints, the socket shall be without the centering ring.

In the case of flanged pipes the flanges shall be at the right angles to the axis of the pipe and machined on face. The bolt holes shall be drilled and located symmetrically off the centre line. The bolt hole circle shall be concentric with the bore and bolt holes equally spaced. The flanges shall be integrally cast with the pipes and fittings and the two flanges of the pipe shall be correctly aligned.

(d) Testing

(i) Mechanical Tests

Mechanical tests shall be carried out during manufacture of pipes and fittings as specified in relevant IS codes. The results so obtained shall be considered to represent all the pipes and fittings of different sizes manufactured during that period and the same shall be submitted to the Engineer. The method for tensile tests and the minimum tensile strength requirement for pipes and fittings shall be as per relevant IS codes.

(ii) Brinell Hardness Test

For checking the Brinell hardness, the test shall be carried out on the test ring or bars cut from the pipes used for the ring test and tensile test in accordance with IS 1500.

(iii) Retests

If any test piece representing a lot fails in the first instance, two additional tests shall be made on test pieces selected from two other pipes from the same lot. If both the test results satisfy the specified requirements, the lot shall be accepted. Should either of these additional test pieces fail to pass the test, the lot shall be liable for rejection.

(iv) Hydrostatic test

For hydrostatic test at works, the pipes and fittings shall be kept under test pressure as specified in relevant IS codes for 15 seconds, they may be struck moderately with a 700 g hammer. They shall withstand the pressure test without showing any leakage, sweating or other defect of any kind. The hydrostatic test shall be conducted before coating the pipes and fittings.

(e) Coating

Coating shall not be applied to any pipe and fitting unless its surface is clean, dry and free from rust. All pipes and fittings shall be coated externally and internally with the same material, by dipping in a tar or suitable base bath. The pipe and fitting may be either preheated before dipping or the bath may be uniformly heated. The coating material shall set rapidly with good adherence and shall not scale off. In all instances where the coating material has a tar or similar base, it shall be smooth and tenacious and hard enough not to flow when exposed to a temperature of 65^{o} C, but not so brittle at a temperature of 0^{0}C as to chip off when scribed lightly with a penknife. In case of pipes and fittings which are imperfectly coated or where the coating does not set or conform to the required quality, the coating shall be removed and the pipes and fittings recoated.

In case the pipes are to be used for conveying potable water, the inside coating shall not contain any constituent soluble in such water or any ingredient which could impart any taste or odour whatsoever to the potable water after disinfection and suitable washing of the mains.

(f) Marking

Each pipe and fitting shall have cast, stamped or indelibly painted on it the following appropriate marks:

i) The nominal diameter.
ii) Flow direction and line marks for installation
iii) Class reference
iv) Mass of pipe
v) Date of manufacture and
vi) Manufacturer's name, initials or identification mark.

Marking shall be done as per relevant IS code.

8.47 Jointing

(a) General

Jointing of CI pipes and fittings shall be done as per the requirements of following Employer's Requirements and as per the relevant IS. After jointing, extraneous material, if any, shall be removed from the inside of the pipe. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382.

(b) Tyton joints

In jointing cast iron spigot and socket pipes and fittings with tyton flexible joints the contractor shall take into account the manufacture's recommendations as to the methods and equipment to be used in assembling the joints. In particular the contractor shall ensure that the spigot end of the pipe to be jointed is smooth and has been properly chamfered, that the rubber ring as per IS: 5382, is correctly positioned in line, before the joint is made. The rubber rings and any recommended lubricant shall be obtained only through the pipe supplier or as otherwise directed by Engineer.

(c) Flanged Pipes

The gaskets used between flanges of pipes shall be compressed fibre board or natural/synthetic rubber conforming to IS: 638, of thickness between 1.5 to 3 mm. The fibre board shall be impregnated with chemically neutral mineral oil and shall have a smooth and hard surface. Its weight per square metre shall be not less than 112 g/mm thickness.

Each bolt should be tightened a little at a time taking care to tighten diametrically opposite bolts alternately. The practice of fully tightening the bolts one after another is highly undesirable. The bolts shall be of mild steel unless otherwise specified.

(d) Cleaning of Pipes and Fittings

The Contractor shall ascertain that each stretch of pipeline is absolutely clear and without any obstruction by means of visual examination of the interior of pipeline suitably lighted by projected sunlight or otherwise. The open end of an incomplete stretch of pipeline shall be securely closed as may be directed by the Engineer to prevent entry of mud or silt etc.

If as a result of the removal of any obstructions the Engineer considers that damages may have been caused to the pipeline, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory, contractor shall amend the work and carry out such further tests as are required by the Engineer.

(e) Testing at work site

After the pipes and fittings are laid, jointed and the trench partially backfilled except at the joints the stretch of pipe line as directed by Engineer shall be subjected to pressure test and leakage test. Where any section of the pipeline is provided with concrete thrust blocks or anchorages, the pressure test shall not be made until at least five days have elapsed after the concrete was cast. If rapid hardening cement has been used in these blocks or anchorages, the tests shall not be made until atleast two days have elapsed.

Each section of the pipe line shall be slowly filled with water and all air shall be expelled from the pipe by tapping at points of highest elevation before the test is made and plugs inserted after the tests have been completed. The specified test pressure based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge, shall be applied by means of a pump connected to the pipe as directed by the Engineer.

The duration of test shall not be less than 5 minutes. The exposed joints shall be carefully examined and all such joints showing visible leaks shall be recaulked until water tight. Any cracked or defective pipes and fittings in consequence of this pressure test shall be removed and replaced by sound material by Contractor at no extra cost to the Engineer and the test shall be repeated to the satisfaction of the Engineer.

After the satisfactory completion of pressure test, the section of pipe line shall be subjected to leakage test. The duration of test shall be 2 hours. No pipe installation shall be accepted until the leakage is less than the number of cm3 /h as determined by the formula:

$$q_L = \frac{ND\sqrt{P}}{3.3}$$

Where,

q_L	=	The allowable leakage in cm^3/hr
N	=	Number of joints in the length of the pipeline
D	=	Diameter in mm, and
P	=	The average test pressure during the leakage test in Kg/cm^2

Should any test of pipe laid indicate leakage greater than that specified above, the defective joints shall be repaired by Contractor at no extra cost to the Engineer until the leakage is within the specified allowance.

Necessary equipment and water used for testing shall be arranged by Contractor at his own cost. Damage during testing shall be Contractor's responsibility and shall be rectified by him at no extra cost to the

Engineer. Water used for testing shall be removed from the pipe and not released in the excavated trenches.

After the tests mentioned above are completed to the satisfaction of the Engineer, the backfilling of trenches shall be done as per the Employer's Requirements specified elsewhere.

8.48 Un plasticised PVC Pipes and Fittings

Unplasticised polyvinyl chloride pipes, fittings and specials shall be to BS 3505 for potable water and BS 4346: Part 1 for fittings.

The pipes shall be of the spigot and socket type with approved gasket type flexible joint. The rubber gaskets shall be to BS 2494, Class C.

Where PVC pipes, fittings and specials are to be connected to cast iron, stainless steel or steel pipes, all metallic pipes, 'Viking Johnson' type flange adaptors or stepped couplings shall be used.

a) Polyethylene Pipes

Polyethylene pipes shall comply with BS 6437. The welding method shall be adapted to international standard and contractor shall obtain the approval of the Engineer before proceeding with such works.

b) Rubber Hosing

Rubber hosing shall conform to BS 5119, Type 2. It shall be capable of handling chlorine and sulphur dioxide solutions at a working pressure of 12 bar.

c) Copper Tubes and Fittings

Copper tubing and fittings for work above ground level shall comply with BS 2871 and BS 864: Part 2 respectively and be jointed with capillary joints. For underground location the copper pipe shall be to BS 2871: Part 1.

d) Flanged Joints

All flanges shall comply with BS EN 1092-1/BS 4504. The nominal pressure rating for particular flanges shall be at least equal to the highest pressure rating of the pipes or fittings to which they are attached, but with a minimum nominal pressure of PN 10. All flanges shall be provided with all necessary nuts, bolts, washers and gaskets. In general, valves shall have flanged body ends.

All flanged joints which are buried or in chambers shall be protected with Densomastic and Densotape wrapping, applied in accordance with the manufacturer's instructions.

Flanges shall be installed on the pipes in the factory and field welding of flanges shall only be allowed with the approval of the Engineer.

Where pipework outside pumping stations and surge vessel chambers is cathodically protected, an insulated flange shall be incorporated at the first flange inside the structure. These flanges shall be tested to ensure that electrical insulation is achieved.

e) Gaskets and Joint Rings

Joint rings shall be manufactured to conform with BS 2494 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80^{o}C.

Gaskets may be inside the bolt circle type and shall comply with BS 4865: Part 1. Alternatively the gasket shall be to the full diameter of the flange, drilled to suit the appropriate bolt provisions.

Chloroprene rubber with a hardness of 71 to 80 IRHD shall be used.

Joints shall be made in accordance with manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any soluble constituent, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

After cleaning the flanges the gaskets shall be fitted smoothly to the flange and the joint shall be made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

f) Flexible Couplings and Flange Adaptors

Flexible couplings and flange adaptors shall be of the Viking Johnson or similar approved pattern and be assembled in accordance with the manufacturer's instructions and protected, if buried or in chambers with Densomastic and Densotape wrapping applied in accordance with the manufacturers' instructions. Flexible joints shall be harnessed or tied where necessary

8.49 Storage & Shipment

a) Protection of Pipes and Fittings for Shipment

Except where otherwise specified all items shall have received their complete protective coatings before dispatch from the manufacturer's works and shall be additionally protected by approved means for the period of transit, storage and erection, against corrosion and accidental damage.

For the protection of pipe linings and in particular for protecting cement mortar linings from drying out, protective metal or timber discs shall be fitted over the ends of pipes and fittings. Similar timber protective discs shall be attached to all flanges of pipes and fittings, by means of bolts specifically provided for the purpose and which shall be discarded when the item is incorporated in the Works. The sleeves and flanges of flexible joints shall be wired together in suitable bundles.

b) Storage of Pipeline Materials

Pipes and fittings shall be stored raised off the ground, and shall be carefully supported, cushioned and wedged. Pipes shall not rest directly on one another and shall not be stacked more than four pipes high or two pipes high in the case of pipes of 500 mm diameter or over. Special care shall be taken to ensure that flexible pipes are cradled and supported in a manner that prevents any distortion of the pipes.

Couplings and joints (and all components thereof) and other similar items shall be stored in dry conditions, raised from the ground in sheds or covered areas.

Storage areas shall be carefully set out to facilitate unloading, and checking of materials with different consignments stacked or stored separately with identification marks clearly visible.

Where items to be stored have a limited shelf life or require special storage arrangements, the method of storage shall be to the approval of the Engineer and in accordance with the manufacturer's instructions.

All pipes and fittings supplied as spares shall have end covers which are proof against the entry of sand and vermin. Mortar lined pipes and fittings shall have end covers which form a complete seal, provision being made to accommodate the effects of temperature changes. Pipes and fittings supplied as spares shall have a temporary white external finish and shall be stored sheltered from the direct rays of the sun.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

8.50 Transportation of Pipes and Fittings

Any vehicle on which pipes are transported shall have a body of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads properly secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.

Approved slings shall be used and all hooks and dogs and other metal devices shall be well padded. Hooks engaged on the inner wall surface at pipe ends shall not be used. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes are kept at a minimum.

Pipe handling equipment shall be maintained in good repair and any equipment which in the opinion of the Engineer may cause damage to the pipes shall be discarded.

Under no circumstances shall pipes be dropped, be allowed to strike one other, be rolled freely or dragged along the ground.

8.51 Inspection of Pipes and Fittings

Before incorporating into the Works each pipe shall be brushed out and carefully examined for soundness. Damaged pipes which in the opinion of the Engineer cannot be satisfactorily repaired shall be rejected and removed from Site.

Damage to pipe coatings or linings shall be repaired to the satisfaction of the Engineer.

Built-in Pipe work and other Plant

The pipes and other Plant in water retaining structures shall, wherever possible, be built in as the work on the structure proceeds. The Contractor shall ensure that delivery of the requisite pipe work and other Plant is in accordance with the requirements of the programme.

Where a pipe subject to thrust passes through a concrete structure or where an external seal is required, a puddle flange shall be used. The puddle flange dimensions shall be to BS EN 1092-1/BS 4504 but shall be undrilled. The exterior of the pipe shall be cement washed symmetrically about the puddle flange by the manufacturer for a length at least equivalent to the thickness of the wall through which it passes.

The Contractor shall be responsible through every stage of the Works for checking the correctness of the setting of built-in Plant and shall satisfy himself they are positioned in accordance with his approved drawings.

8.52 Pipe laying

a) Carting & Handling

Pipes and fittings /specials shall be transported from the factory to the work sites at places along the alignment of pipeline as directed by the Engineer. Contractor shall be responsible for the safety of pipes and fittings/specials in transit, loading/unloading. Every care shall be exercised in handling pipes and fittings/specials to avoid damage. While unloading, the pipes and fittings/specials shall not be thrown down from the truck on to hard surfaces. They should be unloaded on timber skids with steadying ropes or by any other approved means. Padding shall be provided between coated pipes, fittings/specials and timber skids to avoid damage to the coating. Suitable gaps between pipes should be left at intervals in order to permit access from one side to other. In case of spigot socket pipes, care should be taken regarding orientation of pipes while unloading. As far as possible pipes shall be unloaded on one side of the trench only. The pipes shall be checked for any visible damage (such as broken edges, cracking or spalling of pipe) while unloading and shall be sorted out for reclamation. Any pipe which shows sufficient damage to preclude it from being used shall be discarded. Dragging of pipes and fittings/specials along concrete and similar pavement with hard surfaces shall be prohibited.

b) Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes laid lengthwise and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.

Fittings/Specials shall be stacked under cover and separated from pipes.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals. Particularly in the field where the rubber rings are being used it is desirable that they are not left out on the ground in the sun or overnight under heavy frost or snow conditions.

8.53 Laying

a) Excavation

Before excavating the trench the alignment of pipeline shall be approved by the Engineer. The excavation of trenches and pits for manholes/ chambers shall be carried out in accordance with the Employer's Requirements described elsewhere and shall be done such that it does not get far ahead of the laying operation as approved by the Engineer.

To protect persons from injury and to avoid damage to property, adequate barricades, construction signs, red lanterns and guards as required shall be placed and maintained during the progress of the construction work and until it is safe for the traffic to use the roadways. The relevant Indian Standards and the rules and regulations of local authorities in regards to safety provisions shall be observed.

Suitable fencing shall be provided along the sides of trenches and pits. The posts of fencing shall be of timber securely fixed in the ground not more than 3 m apart and they shall not be less than 75 mm in diameter or less than 1.2m above surface of the ground. There shall be two rails, one near the top of the post and the other about 450mm above the ground and each shall be from 50mm to 70mm in diameter and sufficiently long to run from post to post to which they shall be bound with strong rope. The method of projecting rails beyond the post and tying them together where they meet will not be allowed on any account. All along the edges of the excavation trenches a bank of earth about 1.2 m high shall be formed where required by the Engineer for further protection.

The road metal and also the rubble packing shall first be stripped off for the whole width of the trench/pit and separately deposited in such place or places as may be determined by the Engineer.

During excavation, large stones and rubble shall be separated and removed from the excavated soil and stacked separately. The material from excavation shall be deposited on either side of the trench leaving adequate clear distance from the edges of the trench and pit, or as may be necessary to prevent the sides of the trench pit to slip or fall, or at such a distance and in such a manner as to avoid covering fire hydrants, sluice valves, manholes and covers etc. and so as to avoid abutting the wall or structure or

causing inconvenience to the public and other service organizations or otherwise as the Engineer may direct.

Contractor shall take into account additional excavation if any as the Engineer may require in order locating the position of water pipes, drains, sewers etc. or any other works which may be met with, in or about the excavation of trenches/pits while quoting the rates for excavation of trenches /pits while quoting the rates of excavation. Such service lines if met with during excavation shall be properly maintained by Contractor, by means of shoring, strutting, planking over, padding or otherwise as the Engineer may direct, and shall be protected by the Contractor from damage during the progress of the work. All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure /pipe line of water, gas, sewage etc.

Utmost care shall be taken to see that the width of the trench at the top of pipe is not more than the minimum requirement. In case additional width is required it shall be provided only in the top portion from the ground level upto 300 mm above the top of pipe. If any extra width is provided in the area below this portion, Contractor shall have to provide remedial measures in the form of lime concrete or rubble masonry otherwise at the discretion and to the satisfaction of the Engineer. If rock is met with, it shall be removed to 15 cm below the bottom of pipes and fittings/specials and the space resulting shall be refilled with granular materials and properly consolidated. Bottom of trenches/pits shall be saturated with water well rammed wherever the Engineer may consider it necessary to do so.

Wherever a socket or collar of pipe or fitting/ special occurs, a grip is to be cut in the bottom of the trench or concrete bed to a depth of at least 75 mm below the bed of the pipe so that the pipe may have a fair bearing on its shaft and does not rest upon its socket. Such grip shall be of sufficient size in every respect to admit the hand all around the socket in order to make the joint and the grip shall be maintained clear until the joint has been approved by the Engineer.

When welding is to be carried out with the pipes and specials in the trench, additional excavation of not more than 60cm in depth and 90 cm in length shall be made at joints in order to facilitate welding.

The excess excavated material shall be carried away from site of works to a place up to a distance as directed by the Engineer. This shall be done immediately so as not to cause any inconvenience to the public or traffic. If the instructions from Engineer are not implemented within seven days from the date of instructions to cart the materials and to clear the site, the same shall be carried out by the Engineer and any claim or dispute shall not be entertained in this respect.

b) Dewatering

During the excavation, if subsoil water is met with Contractor shall provide necessary equipment and labourers for dewatering the trenches. The Contractor shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the Engineer. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, the Contractor shall take necessary permission from the local authorities.

c) Special Foundation in Poor Soil

Where the bottom of the trench and sub grade is found to consist of material which is unstable to such a degree that in the opinion of the Engineer, it cannot be removed and replaced with an approved material thoroughly compacted in place to support the pipe properly, a suitable foundation for the pipes, consisting of piling, timbers or other materials, in accordance with relevant drawings to be prepared by the Contractor and as instructed by the Engineer shall be constructed.

d) Wooden Shoring

Contractor shall suitably design polling boards, waling and struts to meet different soil conditions that might be encountered in excavating trenches/pits. The horizontal and vertical spacing of struts shall be such that not only the sides of trenches shall be prevented from collapse but also easy lowering of pipe in trenches shall be ensured without creating undue obstructions for the excavation of the work. Any inconvenience and/or delay that might be caused in lowering pipes in trenches as a result of adopting improper spacing of struts by Contractor shall be his sole responsibility. No part of shoring shall at any time be removed by Contractor without obtaining permission from the Engineer. While taking out shoring planks the hollows of any form must simultaneously be filled in with soft earth well rammed with rammers and with water.

The Engineer may order portions of shoring to be left in the trenches /pits at such places, where it is found absolutely necessary to do so to avoid any damage which may be caused to buildings, cables, gas mains, water mains, sewers etc. in close proximity of the excavation, by pulling out the shoring from the excavations. The Contractor shall not claim, on any reason whatsoever, for the shoring which may have been left in by him at his own discretion.

e) Steel Plate Shoring

Where the subsoil conditions are expected to be of a soft and unstable character in trench/pit excavation, the normal method of timbering may prove insufficient to avoid subsidence of the adjoining road surfaces and other services. In such circumstances, the Contractor will be required to use steel trench sheeting or sheet piling adequately supported by timber struts, waling etc., as per the instructions, manner and method directed by the Engineer. Contractor shall supply pitch, drive and subsequently remove trench sheeting or piling in accordance with other items of the Employer's Requirements.

f) Boning Staves and Sight Rails

In laying the pipes and fittings/ specials the centre for each manhole / chamber or pipeline shall be marked by a peg. Contractor shall dig holes for and set up two posts (about 100 x 100 x 1800 mm) at each manhole/chamber or junction of pipelines at nearly equal distance from the peg and at sufficient distances there from to be well clear of all intended excavation, so arranged that a sight rail when fixed at a certain level against the post shall cross the centre line of the manhole/chamber or pipe lines. The sight rail shall not in any case be more than 30 m apart; intermediate rails shall be put up if directed by the Engineer.

Boning staves of 75 mm x 50 mm size shall be prepared by Contractor in various lengths, each length being of a certain whole number of meters and with a fixed tee head and fixed intermediate cross pieces, each about 300 mm long. The top-edge of the cross piece must be fixed below the top-edge of the tee-head at a distance equal to the outside diameter of the pipe or the thickness of the concrete bed to be laid as the case may be. The top of cross pieces shall indicate different levels such as excavation for pipe line, top of concrete bed, top of the pipe etc. as the case may be.

The sight rail of size 250 mm x 40 mm shall be screwed with the top edge resting against the level marks. The center line of the pipe shall be marked on the rail and this mark shall denote also the meeting point of the center lines of any converging pipes. A line drawn from the top edge of one rail to the top edge of the next rail shall be vertically parallel with the bed of the pipe, and the depth of the bed of pipe at any intermediate point may be determined by letting down the selected boning staff until the tee head comes in the line of sight from rail to rail.

The post and rails shall be perfectly square and planed smooth on all sides and edges. The rails shall be painted white on both sides, and the tee-heads and cross-piece of the boning staves shall be painted black.

For the pipes converging to a manhole/chamber at various levels, there shall be a rail fixed for every different level. When a rail comes within 0.60 M of the surface of the ground, a higher sight-rail shall be fixed for use with the rail over the next point.

The posts and rails shall in no case be removed until the trench is excavated, the pipes are laid and the Engineer gives permission to proceed with the backfilling.

g) Laying of Pipes and Fittings/Specials

All precautions shall be taken during excavation and laying operations to guard against possible damage to any existing structure/pipeline of water, gas, sewage etc. After excavation of trenches, pipes shall not be lowered unless the dimensions of trenches and bedding work for pipes at the bottom of the trenches are approved and measured by Employer /Engineer. Pipes and fittings/specials shall be carefully lowered in the trenches. Special arrangements such as cranes, tripods with chain pulley block for lowering the pipes and fittings/specials shall be made by Contractor. In no case pipes and fittings/specials shall be dropped. Slings of canvas or equally non-abrasive material of suitable width or special attachment to fit the ends of pipes and fittings/specials shall be used to lift and lower the coated pipes and fittings/specials. The pipes and fittings /specials shall be inspected for defects and be rung with a light hammer preferably while suspended to detect cracks. If doubt persists, further confirmation shall be done by pouring a little kerosene/dye on the inside of the pipe at the suspected spot. No sign of kerosene/dye should appear on the outside surface. Pipes and fittings/specials damaged during lowering or aligning shall be rejected by the Engineer.

All the pipes are to be laid perfectly true both in alignment and to gradient specified. In case of spigot and socket pipe the socket end of the pipe shall face upstream, except when the pipeline runs uphill in which case the socket ends should face the upgrade. The laying of pipes shall always proceed upgrade of a slope. After placing a pipe in the trench, the spigot end shall be centered in the socket and the pipe forced home and aligned to required gradient. The pipes shall be secured in place with approved backfill material tamped under it except at the socket. Pipes and fittings/specials which do not allow a sufficient

and uniform space for joints shall be removed and replaced with pipes and fittings/specials of proper dimensions to ensure such uniform space. Precautions shall be taken to prevent dirt from entering the jointing space. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug or other means approved by the Engineer. During the period that the plug is on, the Contractor shall take proper precautions against floating of the pipe owing to entry of water into the trench. Wherever it is necessary to deflect pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions or where long radius curves are permitted the deflection allowed at joints shall not exceed 2 ½0. In case of pipes, with joint to be made with loose collars, the collars shall be slipped on before the next pipe is laid. The pipes shall be laid such that the marking on pipes appears at the top of the pipes.

The cutting of pipe for inserting valves, fittings, or specials shall be done in a neat and workman like manner without damage to the pipe so as to leave a smooth end at right angles to the axis of the pipe. For this purpose, pipe cutting machine shall be used.

h) Thrust Blocks

Thrust Blocks shall be provided for all piping works, to counteract hydraulic thrust, at places wherever directed by the Engineer as per approved design.

i) Jointing

Jointing for pipes and fittings/specials shall be done in accordance with the relevant Employer's Requirements depending upon the type of pipes being used.

j) Testing and Commissioning

Testing and commissioning of pipes shall be done in accordance with the relevant Employer's Requirements.

k) Backfilling

Trenches shall be backfilled with approved selected excavated material only after the successful testing of the pipeline. The tamping around the pipe shall be done by hand or other hand-operated mechanical means. The water content of the soil shall be as near the optimum moisture content as possible. Filling of the trench shall be carried out simultaneously on both sides of the pipe in such a manner that unequal pressure does not occur. Backfilling shall be done in layers not exceeding 30 cm. Each layer shall be consolidated by watering, ramming, care bring taken to avoid damage to the pipeline. In case of the mild steel pipes/specials, the spiders provided during assembly and welding shall be retained until the trench is refilled and consolidated. Where timbers are placed under the pipeline to aid alignment, these timbers shall be removed before backfilling.

The Contractor is requested to provide the method of Backfilling compaction test and evaluation value and obtain the approval from the Engineer.

l) Reinstatement of Road/Footpath

Reinstatement of road/footpath shall be done as per the requirements of local authorities and the Employer's Requirements after completion of work.

m) Clearing of Site

All surplus materials, and all tools and temporary structures shall be removed from the site as directed by the Engineer and the construction site left clean to the satisfaction of the Engineer.

8.54 Disinfection of Water Mains

The mains intended for potable water supplies should be disinfected before commissioning them for use. Special care should be taken to ensure disinfection of new mains. Among possible sources of contamination are sewer drainage, contaminated soil in the trench, contamination from workmen or their equipment of both and unavoidable foreign material present in the trench during construction.

Education of crew members as to the need for avoiding contamination of the main during construction is fundamental. Contractors and workmen should be thoroughly familiar with all pertinent state and local requirements governing installation of mains. All sewers, water mains and other underground conduits should be located prior to construction relocated, if necessary, to prevent contamination during construction. Pipe should be strung on high ground. At all times when construction is not actually in progress, watertight plugs should be installed in all pipe openings. Gunny sack and rags are not adequate. Provision should be made to pump any other water that might collect in the trench. Special care should be taken to avoid contamination of valves, fittings, and pipe interiors, both before and during construction each of them should be inspected and, if necessary, cleaned before installation.

After pressure testing the main, it should be flushed with clean water at sufficient velocity to remove all dirt and other foreign materials in the constructed pipeline. When this process has been completed, disinfection (using liquid chlorine, sodium or calcium hypochlorite) should proceed by one of the recommended methods as described in the following

Continuous Feed

In this method, water from the distribution system or other approved source and the chlorine is fed at constant rate into the new main at a concentration of at least 20 mg/1. A property adjusted hypochlorite solution injected into the main with a hypo chlorinator, or liquid chlorine injected into the main through a solution feed chlorinator and booster pump may be used. The chlorine residual should be checked at intervals to ensure that the proper level is maintained. Chlorine application should continue until the entire main is filled. All valves, hydrants, etc., along the main should be operated to ensure their proper disinfection. The water should remain in the main for a minimum of 24 hours. Following the 24 hours period no less than 10 mg/1 chlorine residual should remain in the main.

The Contractor is requested to provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work.

The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved.

Waste chlorine residual water must be neutralized before it is discharged to any drainage.

Slug Method

In this method a continuous flow of water is fed with a constant dose of chlorine (as in the previous method) but with rates proportioned to give a chlorine concentration of at least 300 mg/1. The chlorine is applied continuously for a period of time to provide a column of chlorinated water that contacts all interior surfaces of the main for a period of at least 3 hours. As the slug passes tees, crosses, etc., proper valves shall be operated to ensure their disinfection. This method is used principally for large diameter mains where continuous feed is impractical.

Regardless of the method used, it is necessary to make certain that backflow of the strong chlorine solution into the supplying line does not occur. Following the prescribed contact period, the chlorinated water should be flushed to waste until the remaining water has a chlorine residual approximating that throughout the rest of the system. Bacteriological tests as prescribed by the authorities should be taken, and if the results fail to meet minimum standards, the disinfecting procedure should be repeated and the results again tested before placing the main in service.

If continuous feed method is difficult to apply, Retention Method shall be considered as alternative way.

The area or pipe line to be disinfected shall be fed with chlorine solution from up stream under flowing water condition, and then the area shall be blocked after make sure to reaching more than 20 mg/l. The chlorine solution fed in the pipeline needs to wait for 1 day before starting measurement of residual chlorine. After 3 days later, the chlorine residual value shall be tested at sampling points at up stream and at downstream near to end to check whether the value is in range or not.

The Contractor shall provide photo and take a record the value of chlorine residual at starting point and after 24 hours before completion of work.

The Engineer shall jointly check the test at sites. If the value is insufficient, the disinfections work shall be repeated until satisfactory results are achieved.
Waste chlorine residual water must be neutralized before it is discharged to any drainage, as approved by Engineer.

8.55 Macerators

Equipment shall be designed and selected for continuous duty grinding of concentrated solids derived from the municipal wastewater. Grinders shall be suitable for grinding small particles of wood, industrial solvents, greases, detergents, rags, hair, wipes, and organic particles in concentrations as great as 7

percent. The grinder fluids are expected to range in temperatures between 60 degrees F and 140 degrees F, and the pH may vary between 6 and 9.

When mounting in the channel, the grinder shall have mounting rails for easy removal for field service and repair.

Grinders and motor controllers shall meet the requirements of the following industry standards:

1. ASTM A536-84 - Standard Specification for Cast Iron Castings.

2. ASTM A36 – Standard Specification for Carbon Steel Plate.

3. AISI 4140 - Heat Treated Round Steel.

4. AISI 4130 - Heat Treated Alloy Steel.

5. National Electrical Manufacturer's Association Standards (NEMA).

8.54.1 Materials

Casting: Cast iron ASTM A48 GG20, 20 – 26 Rockwell C

Wear Plates and Counter Blades: Hardox Carbon Steel, 43 Rockwell C

Cutters: High Wear Resistant Steel, nitrated, 60-65 Rockwell C

Shafts: Alloy steel, AISI 4140

8.54.2 Grinders

A. General

1. The sewage grinder(s) shall be two-shaft design and be capable of continuous operation, processing wet or dry. Single shaft devices utilizing a single rotating cutter bar with stationary cutters will not be acceptable.

2. Two-shaft design shall consist of two parallel shafts equipped with monolithic cutter assemblies positioned on the shaft to form a helical pattern. If multiple cutter packages are used, O-rings shall be incorporated between each cutter package. Individual cutter and spacers will not be acceptable. The two shafts shall counter-rotate with the driven shaft operating at different speed then the speed of the drive shaft.

B. Components

1. Grinder gearbox housings shall be cast of ASTM A48 cast iron.

2. The bottom end housing shall be manufactured of carbon steel and bolted together to be field changeable on demand.

3. Grinder housing segments shall be manufactured of 1018 mild steel, bolted together.

4. High Flow side rails shall be installed on the sides of the housing to guiding particles directly into the cutting chamber while allowing liquid to pass. The side rails shall be evenly spaced to provide maximum flow, with clearance shall not exceed .11-inches (3 mm), and have a thickness of .16-inches (5 mm).

5. The top and bottom counter blade plates shall be manufactured of Hardox, minimum hardness of 43 Rockwell C (500 Brinell) or equivalent, and provide counter cutting action to protect against build up in the top and bottom of the grinder.

6. Grinder drive and driven shafts shall be made of 4140 alloy heat-treated round steel with a tensile strength rating of not less than 149,000 psi (1027 Mpa) or equivalent

Each shaft diameter shall be a minimum of 1.73 inches (44 mm).

7. Mounting frames, overflow boxes, rail system and required hardware shall be made of 316 SS.

8. Cutters & Blades

a. Cutting stack shall have a nominal height as per project requirement.

b. Cutter shall be manufactured from a monolithic assembly constructed from a solid block of alloy steel surface ground to a blade thickness of .37-inches +.000/-.001 (9.5 mm +.000/-.003).

c. Cutters shall be heat treated to produce a hardness of 60-65 Rockwell C.

d. Cutters shall be nitrated for high corrosion resistance.

e. Cutters shall have 8 cam shaped teeth.

f. Cutter tooth height shall not be greater than ½-inch (13 mm) above the root diameter of the cutter.

g. Cutter assembly OD shall be 4.72-inches (120 mm) minimum. Spacer shall be cut into the monolithic cutter, and shall have a smooth outside diameter with no tooth profiles. Designs with multiple cutters and spacers, or multiple cutter cartridges, or without a single monolithic cutter assembly shall not be acceptable.

9. Bearings and Seals

a. The radial and axial loads of the shafts shall be borne by oversized radial spherical roller bearings on upper and deep groove ball bearings on lower end. The bearings shall be protected by a single cartridge mechanical seals. Seal face materials must be a minimum of chrome oxide, not requiring an external flush, but in a static bath of oil. The mechanical seal shall be rated at 90 psi continuous duty by the seal manufacturer. The bearings and seals shall be housed in a replaceable cartridge that supports and aligns

the bearings and seals, as well as protects the shafts and end housings. The seal elements shall be independent of the stack height. The seal shall meet required pressure rating regardless of cutter stack fit. The seal and bearing cartridge shall provide protection against axial loading on shafts and bearings during shaft detection.

O-rings shall be made of Buna-N elastomers.

10. Electric Motor & Reducer

a. The grinder gearbox shall be a low speed, high-torque parallel shaft gearbox manufactured by Nord Gear or equivalent. Maximum motor speed shall not exceed 1800 rpm, and should provide a minimum of 10% reserve hp as evidenced by specific requirements at maximum design.

b. All motors shall be built in accordance with latest NEMA, IEEE, ANSI and AFBMA standards where applicable.

c. Motor shall be TEFC with a minimum service factor of 1.15

d. Motors shall conform to all requirements stipulated in the motor section of this specification.

e. The motors supplied shall be specifically designed for inverter duty to allow for the potential of future variable frequency drives. The motors shall be compatible with the grinders provided by the MANUFACTURER. The gear speed reducer shall be Nord or equivalent parallel shaft geared type of reducer with "Heavy Shock" load classification. The drive shaft of the grinder shall be directly coupled with the reducer without use of a coupling.

8.54.3 Motor Controllers

A. General

1. Controller shall provide independent control of the grinder.

2. The controller shall be equipped with HAND-OFF/RESET-AUTO three-position selector switch. In OFF/RESET the grinder shall not run. In HAND the grinder shall run. In AUTO the grinder start and stop shall be controlled by a remotely located dry contact.

3. When a grinder jam condition occurs, while running in either the HAND or AUTO mode, the motor controller shall stop the grinder and reverse its rotation to clear the obstruction. If the jam condition still exists, the controller shall go through five additional reversing cycles within 45 seconds before signalling a grinder overload condition. When a grinder overload condition occurs, the controller shall shut the grinder off and activate a fail indication.

4. If the grinder is stopped due to a fail condition and a power failure occurs, the fail indicator shall reactivate when power is restored.

5. Controller reset shall be from local panel controls only.

6. The controller shall have indicator lights for POWER ON, RUN and FAIL conditions.

7. The controller shall provide overcurrent protection for the motor through an overload relay mounted directly on the contactor.

8. The controller shall be rated 3-HP (5-HP), 208/230/460/575V volts, 3 phase, 60 HZ.

9. Short circuit protection requires that a properly sized circuit breaker or fuses be installed by others.

B. Components

1. Enclosure

a. Enclosures shall be NEMA 4 or equivalent, fabricated of polycarbonate reinforced polyester resins for wall mounting. Doors shall have hinges and corrosion resistant latches.
b. Enclosure shall house the control devices, relays, terminal blocks, and grinder reversing motor starter.

2. Control Devices

a. Pilot devices shall be mounted on the enclosure front panel.

b. Indicators shall be LED type lights. Lamps and the selector switch shall be heavy duty NEMA 4 type.

c. Two normally open status contacts shall be provided. One for a RUN signal and one for FAIL signal. The contacts shall be rated at 2-Amp, 240-VAC, resistive load.

d. Control transformer shall be protected by two primary fuses and one secondary fuse. The 120 volt secondary shall have one leg grounded.

3. Motor Starter

a. A reversing contactor type motor starter shall be provided for the motor.

b. Forward and reverse contactors on the starter shall have both mechanical and electrical interlocks.

c. The overload (OL) relay shall be adjustable so that the range selected includes the FLA (full load amperes) rating and service factor.

8.54.4 Spare Parts

Provide the following spare parts for each unit:

1. One (1) complete gaskets & O-ring set.

2. One (1) set of mechanical seals.

3. One (1) set of monolithic cutters.

Grinder spare parts shall be packaged in containers suitable for long term storage and shall bear labels clearly designating the contents and the equipment for which they are intended.

8.56 Step Fine Screens

8.55.1 General

Mechanically operated step screen completely made of Stainless-Steel grade 316 having 6 mm average spacing between the bars shall be provided in inlet screen channel(s) for screening out floating materials such as plastic pouches, bags, rags, floating debris, weeds, paper wastes and other floating materials from the raw sewage coming from the pumping station / gravity mains.

The screen shall include discharge chute as required to discharge the screenings on the belt / screw conveyor without employing any external mechanism / rake mechanism.
The screen shall be factory assembled & movement tested at plant before dispatch to site & shall be installed at the site in factory assembled condition only thereby avoiding chances of misalignments.

8.55.2 Scope

Design, Supply, Installation, Testing & Commissioning of screening equipment consisting of following:

a. Mechanized step screen having 6 mm average spacing between bars and suitable for installation at an inclination of 40 degrees in channel.

b. Level sensing instrument for automatic operation of screen mechanism and allied accessories.

c. Local control panel installed near screen.

d. Belt / screw conveyor to discharge the screened material to the waste bin.

8.55.3 Eligibility Criteria for Manufacturer

Only such screen manufacture shall be considered as eligible who have manufactured & supplied at least ten (10) nos. of similar screens to sewage treatment plants having a capacity of minimum 50 MLD during past two (2) years.

As screens are required in Stainless Steel material to withstand the corrosive and aggressive sewage environment hence the screen manufacturer is expected to follow the best manufacturing practice mentioned here under to further eliminate the possibility of corrosion of screen in a corrosive atmosphere.
The screens should be manufactured in a stainless-steel clean area i.e. in a plant where no ferrous material is cut or welded or handled. This is required for ensuring that no ferrous contamination / pick up takes place because the stainless-steel surfaces subjected to ferrous pick up gets corroded.

Further to this as an additional precaution the manufacturer of screen must have the facility for Pickling and Passivation to remove any ferrous contamination that might have taken place during manufacturing / handling / movement of raw and fabricated material.

As screens are basically fabricated item hence to ensure best workmanship screen manufacturer must have welding PQR, WPS & Qualified welders as per ASME Section 9.

8.55.4 Specification

Material of construction:

The fixed as well as movable bars, mechanism, support frame, fixings discharge chute shall be manufactured from stainless steel grade 316 for long life in the aggressive sewage environment. No component of the screen assembly shall be made of carbon steel or any other material, which can get corroded in sewage environment.

Screen Construction:

The step screen shall be a complete unit comprising of main frame with an integral mechanism containing movable bars located in between fixed bars without engagement of external mechanism / rake mechanism for pulling out the screened material ensuring minimum movement of the mechanism.

The mechanism comprising of movable bars located between fixed bars shall gradually move the screened material upward in the form of a mat and deliver up to the discharge chute.

The fixed as well as movable bars shall contain a series of steps to prevent the screenings from falling back into the main flow.

The mechanism shall be mechanically operated by Electro-motor or hydraulic system and shall be suitable for automatic operation controlled by a level sensor.

The screen shall operate automatically when the upstream water level increases beyond a pre-set limit and it shall stop when the upstream level decreases to a preset low level due to upward travel of screened material.

The fine bar screen shall be capable of being tilted out of the sewage flow up to horizontal position for the purpose of cleaning & maintenance.

The base of the screen shall be fitted with a specially profiled stainless-steel plate to direct any grit that may be present towards the screen and taken out along with other screened material thus reducing the possibility of building up of grit in front of the screen.

Level Sensor

The level Sensor shall be of upstream type Ultrasonic level switch.

Electrical Motor

The motor shall be TEFC type with IP 55 protection & Class F insulation and shall be suitable for operation on 3 phase, 415V + 10% and frequency of 50Hz + 5%.

Control Panel

The control panel shall be constructed from Stainless Steel material grade minimum SS 316 with IP 65 protection and shall be comprising of

a. Mushroom Head Emergency stop.
b. Overload relays for motor protection.
c. MCB's, HRC Fuses and Glass Fuses.
d. Circuitry to operate the screen with level sensors.
e. Selector Switch to operate the screen on JOG mode.

8.55.5 Testing

The Fine bar screen shall be Factory assembled and shall be subjected to following tests at the manufacturer's premises before dispatch.

Dimensional Check: The overall dimensions of the screen shall be conforming to the approved drawing.

Operational Test: The complete screen including its mechanism, Electro-motor/ hydraulic operating mechanism and control panel shall be integrated and mechanically operated in dry condition to verify interference free movement and satisfactory working.

Positive Material Identification (PMI) test: To ensure that Screens are actually made of Stainless Steel Grade 316 positive material identification (PMI) test to be conducted for all important screen components like Bars & Frame during inspection and PMI reports to be submitted to client / corporation along with joint inspection report.

Dye Penetration test: Dye penetration test to be conducted at random for checking the soundness of welding joints during the inspection. Both Procedure as well as person conducting the dye penetration test should be certified by the outside agency as per relevant standard.

Review of test certificate: Material test report / certificate, Motor certificate, Control Panel certificate to be furnished for review during the inspection.

Review of WPS, PQR & Welder's qualification certificate: To be offered for review during the inspection and copy of same to be submitted to client / corporation along with joint inspection report.

8.55.6 Miscellaneous

The installation and commissioning of screens has to be done in the presence of manufacturer's representative(s) so as to avoid any possibility of misalignment and faulty installation.

Packing of screens and allied accessories shall be transit worthy to avoid any possibility of damage during the transportation to the site(s).

End of Part 8